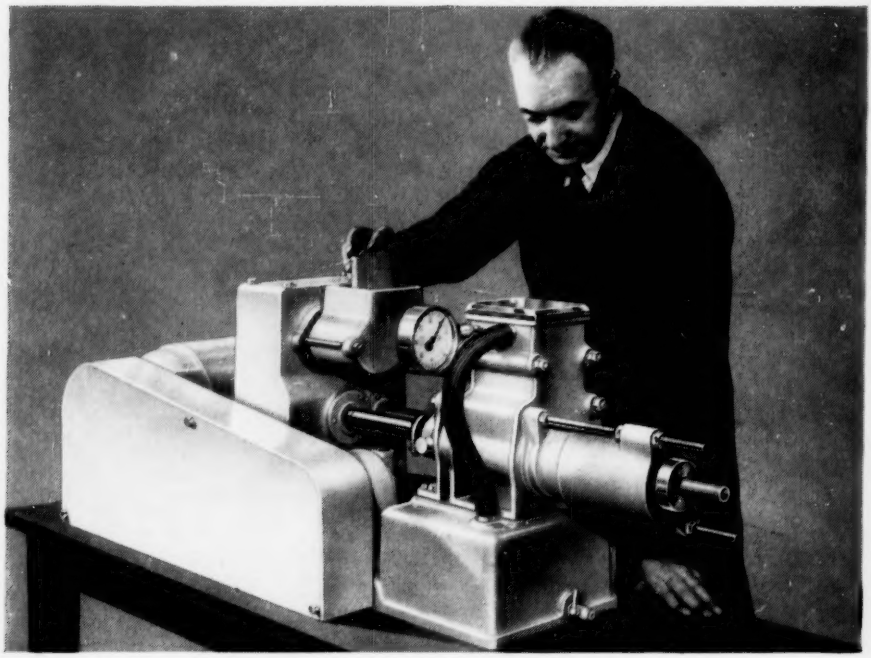
CERAMICS

FEBRUARY
1955

No. 72 Vol. VI



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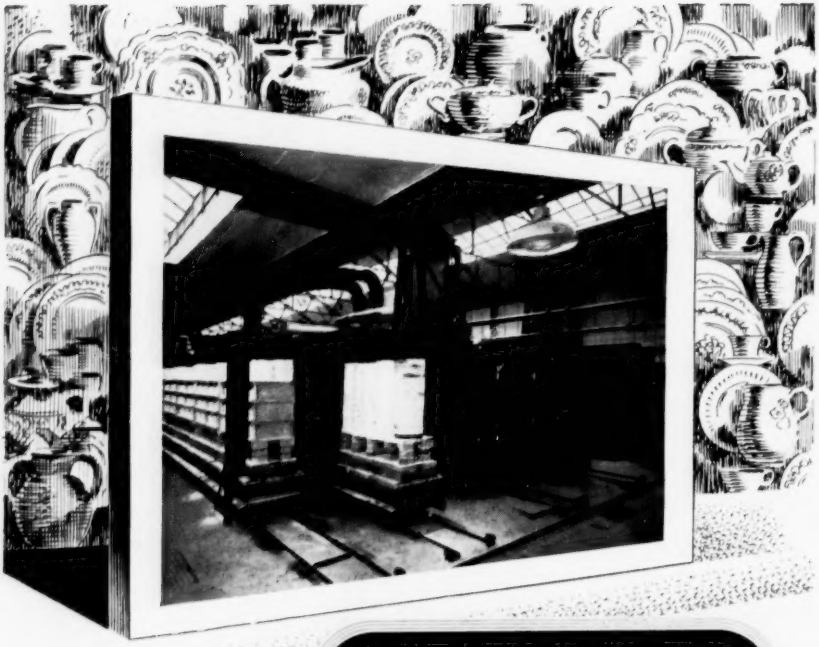

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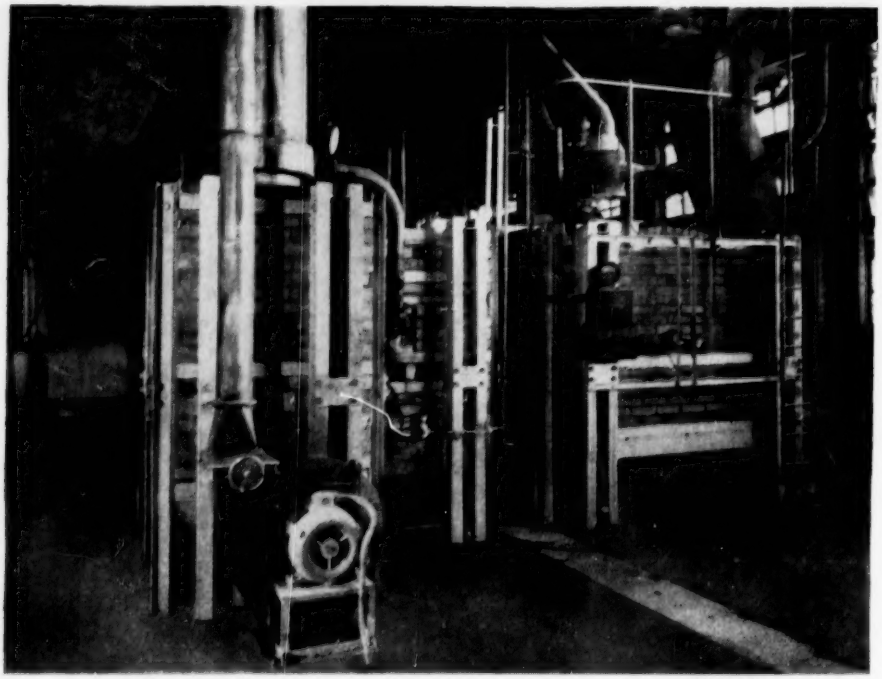

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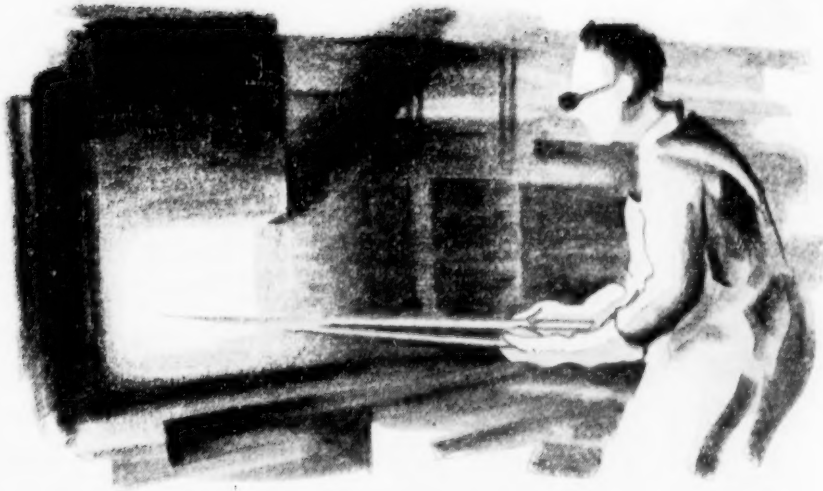

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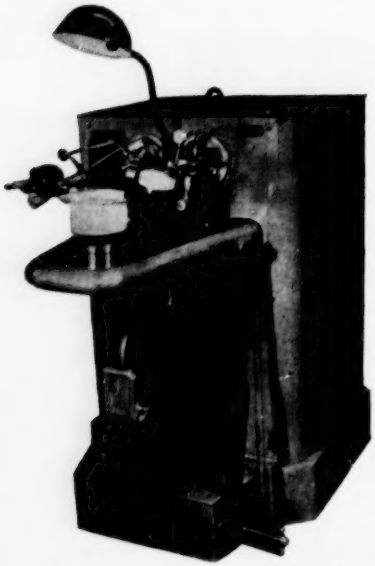

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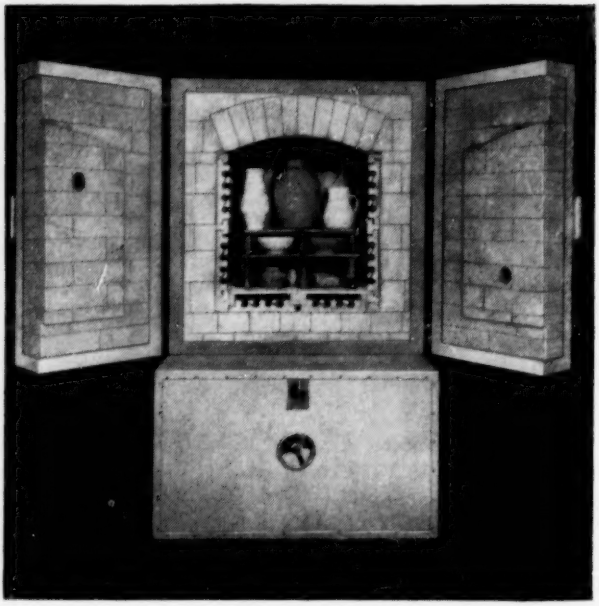

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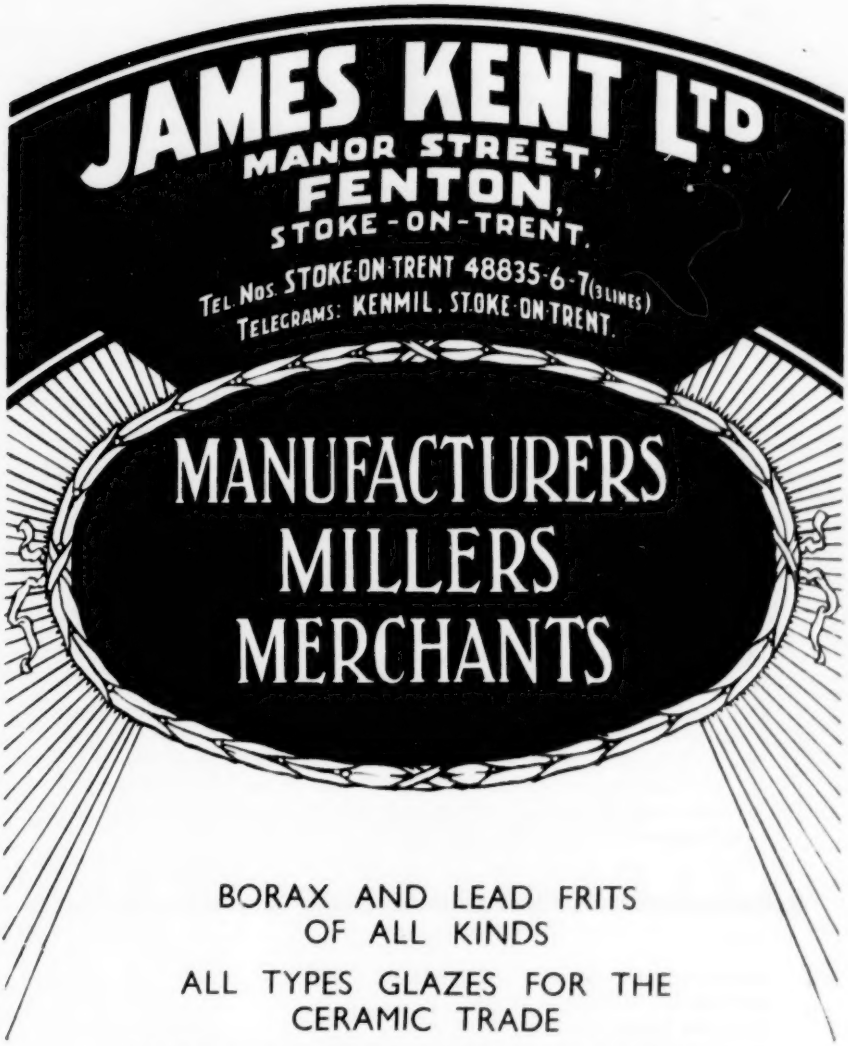

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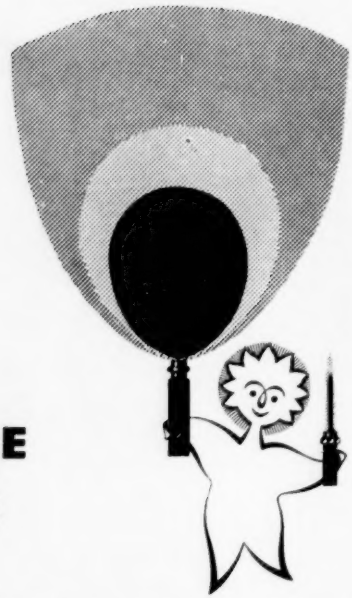

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Published Monthly
by
ARROW PRESS LTD.,
157 Hagden Lane.
Watford, Herts.

DIRECTORS:
(CHAIRMAN)
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CERAMICS

A monthly journal covering the pottery, glass, heavy clay, refractory and silicate industries.

FEBRUARY 1955

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Ceramics

VOL. VI FEBRUARY, 1955 NO. 72

Clean Air

THE Private Members' Bill on Clean Air introduced recently to the House of Commons by Gerald Nabarro, M.P., has won one of the greatest tactical triumphs of a Private Member since the war, and has led directly to a promise from the Government to introduce a comprehensive Clean Air Bill during the current session.

The potteries, of course, are very interested in the question of smoke abatement—but indeed, although up and down the country when reference is made to smoke, attention is usually fixed upon carbonaceous deposits, grit and sulphur dioxide and sulphur trioxide, what is overlooked is that many specific industries also produce a pall of other noxious and dangerous products quite locally.

This was brought out by both Dr. Stross, the Member for Stoke-on-Trent (Central), and Mr. Ellis Smith, Stoke-on-Trent (South), who, criticising the Bill, said there was nothing to protect farmers from the increasing toll that fluoride contamination is taking of their cattle. It so happens that in the areas of the clay industry, contamination from fluorine-containing compounds has become of increasing importance. Dr. Stross drew attention to the experimental farm called The Fenton Manor Farm, where cattle are kept under test conditions and it is possible to see pathological specimens of bones from cattle which are fed on crops and grass contaminated by fluorine compounds.

He stressed that the danger was well known and the loss to agriculture from the destruction of cattle was serious. What is more, he was categorical that the emission of these noxious compounds can be controlled. He quoted one instance where, in July, 1952, fluorine compound deposits contaminated the surrounding countryside to the extent of 560 parts per million, but after installing preventive plant the contamination was down to 8 parts per million.

He also mentioned in passing that we are thinking of putting 2 parts per million fluorine in water for drinking. However, there seems to be considerable divergence of opinion among the medical fraternity as to whether or not this is advisable. One writer has said that fluorine is a waste product of the aluminium industry, and the accusation is made that the United States Federal Security Agency used the taxpayers' money to propagate fluorisation to benefit the American aluminium industry! Examples are quoted of other medical advice which is decidedly against the project.

However, the need for a comprehensive Clean Air Bill and the important part to be played by local authorities is stressed by the example given by Dr. Stross. Specific industries in specific areas emit, in the course of their processing, specific toxic fumes, and it is obviously essential that the local authority must be given power to control these specific fume menaces.

This example serves to prove how important is the collaboration of the local Authorities in any Clean Air project.

The Use of the Noble Metals in the Ceramics Industries

(Specially Contributed)

THE noble metals, gold, platinum and silver, find applications in the ceramic industries for decoration of fine pottery, for application to electroceramics, where it is necessary to make electrical contact, and in pyrometers for measuring temperatures. It is not proposed in this article to deal with the last application.

Decoration of Fine Pottery

Gold and platinum, on account of their cost, are only used for decorating the more expensive types of ware. A possible exception to this is the use of liquid gold on the edges of cups and plates, but here the amount used is very small. The decoration can be considered under two headings:

(a) The use of gold for the preparation of the finest pink, red and purple colours.
(b) The application of the noble metal itself.

The basis of the gold colours is a fine dispersion of gold particles on some inert medium, and it is considered that the colour obtained depends on the size of these colloidal particles. According to Rudolf Hainback (*Pottery Decorating*, (English Translation), second edition, London, 1924) underglaze red and pink colours can be obtained in the following way. Ninety parts of kaolin are placed in water, which is then boiled and passed through a fine sieve. A solution of auric chloride containing the equivalent of ten parts of pure gold is then added with constant stirring, and the whole made alkaline by adding a solution of sodium carbonate drop by drop. The auric chloride is then reduced by adding a solution of 20 parts of glucose and boiling strongly for about 30 minutes, keeping the liquid stirred, and adding fresh water to replace that evaporated. This gives a deep purple-red colour, which is filtered off, washed, and dried. It is then calcined, washed, and ground to the requisite fineness. When the quantity of gold is reduced, a series of lighter colours are produced; as an example, two parts of gold to 98 of kaolin gives a pale rose-pink.

Purple of Cassius

The colloidal gold can also be dispersed on tin oxide, as is done in the preparation of the well-known Purple of Cassius, first made in 1685. Since the shade obtained in preparing gold colours varies with the conditions of preparation (because, possibly, the grain size of the gold is altered) it is important to standardise the method used. As before, the starting point is gold chloride, which is either obtained in a pure form, or can be made from the metal by dissolving in aqua regia (3 parts hydrochloric acid to 1 part of nitric acid). R. Hainback gives a series of recipes for producing Purple of Cassius, and recommends the reader to try them and adopt that which gives the most satisfactory product. It appears that the colour of the product depends on the proportions of stannous and stannic chlorides present in the reducing solution, and on the temperature. Dilution is also important, the richest colours being obtained from the more dilute solutions. C. F. Binns (*Manual of Practical Pottery*, London, fifth edition, 1922) quotes the following recipe for making Purple of Cassius.

One part by weight of brown gold is dissolved in ten parts by weight of aqua regia. Thirty parts by weight of a mixture of hydrochloric acid, nitric acid and water in the ratio, by weight, of 2:1:2, are then taken, and in this mixture 6 parts by weight by granulated tin are dissolved. These solutions are filtered. The gold solution is then poured into a large

volume of distilled water (3 pints is specified for one pennyweight of gold taken originally) and the tin solution slowly added with stirring. 5 pints of hot water are then added and the mixture allowed to stand. When the precipitate has settled it is washed several times by decantation with water, till free from acid, and then collected and partially dried. This serves as a colour base. Before being used it is fluxed.

It is possible to produce other colour bases by varying the proportion of gold and tin in the mixture used for precipitation. In the above recipe for purple the ratio of gold to tin is 1:4 by weight, tin used is 1:6. If the amount of tin is reduced by taking a smaller quantity of tin solution so that the ratio of gold to the precipitate is of a maroon colour, and is referred to as maroon base, while a ratio of gold to tin of 1:5 gives a rose base. A light purple base is obtained with a ratio of 1:10. These bases can be used to produce in addition ruby and pink colours by mixing with fluxes. It is usual to add silver compounds to the colour, too. This is done to impart a purplish tinge. The fluxes specified are of the No. 8 type, and Binns quotes the following:

	Purple Flux	*Rose Flux*	*Maroon Flux*	*Ruby Flux*
Red lead ...	2	6	6	2
Flint glass ...	—	—	2½	—
Boracic acid	—	—	8	—
Cornish stone	—	2	—	—
Borax ...	8	6½	—	9
Flint ...	2¼	5½	—	5¼
Nitre ...	—	1	—	—

They are fritted at easy earthenware glost temperatures before being ground.

The recipes for the various colours are therefore:

Maroon

Maroon base containing 1 pennyweight (24 grains troy) of gold, 16 grains silver carbonate, 1 lb. maroon flux.

Purple

Purple base containing 1 pennyweight of gold, 1 pennyweight silver carbonate, 4 oz. purple flux.

Ruby

Maroon base containing 1 pennyweight of gold, 6 grains silver carbonate, 4 oz. ruby flux.

Rose

Rose base containing 1 pennyweight gold, 12 grains silver carbonate, 1 lb. rose flux.

Pink

Rose base as above. 8 grains silver carbonate, ½ lb. purple flux, ½ lb. rose flux.

A modern practice is understood to be to make Purple of Cassius as the base and then to produce a rose base from this by additions of metallic silver. The maroon and ruby colours are then produced by mixing the rose and purple bases. Details of this have not been made available.

Platinum Grey

Platinum grey is made by dissolving the metal in aqua regia and evaporating to dryness. An equal weight of ammonium chloride dissolved in water is added to form the double salt ammonium chloroplatinate, which separates on evaporation to dryness. This compound is dissolved in water and the solution mixed with ground pitches. On heating the chloroplatinate is decomposed, giving finely divided platinum intimately mixed with the pitches. The result is a fine grey, sometimes used on very expensive ware.

Decoration with Gold

Gold is added to ware either in the form of bright or liquid gold, which needs no burnishing, or as burnish or best gold which needs burnishing after firing to change it from a matt to a bright metallic surface. In either case the gold is applied on the glaze and held there by some form of soft flux, such as bismuth nitrate or No. 8 flux. The starting point is to prepare pure gold, since the commercial material normally contains traces of other metals like copper and silver, which would eventually oxidise and impair the colour of the gold. For this purpose the commercial gold is dissolved in aqua regia. After dilution the liquid is filtered and evaporated to form crystals of gold chloride. These are purified by recrystallising, and are

then dissolved in water. The gold is precipitated out as brown gold by adding a solution of ferrous sulphate, and is then washed and dried.

Brown gold can be mixed with a flux and used for decorating ware, but in order to economise it is commonly mixed with an equal quantity of mercury, the flux added, and the whole ground for a long time—in some works for two weeks. On firing the mercury evaporates, leaving a matt gold surface, which is made bright by rubbing with an agate or blood stone to flatten out the gold particles. The flux used is 5-10 per cent. of bismuth nitrate, with about half that amount of No. 8 flux or a flux high in borate.

The colour of the burnished gold can be varied by the addition of other metals. Used alone, gold tends to give a reddish tone. Additions of silver turn this yellow, and in amounts of up to 50 per cent. the gold assumes a greenish tinge. Copper is also added at times to give a bronze tone. Mixing the gold with large amounts of other metals leads, of course, to the risk of sulphur gases in the atmosphere blackening it. Some examples of the addition of other metals to gold are quoted from C. F. Binns (*op. cit.*).

Medium Burnish Gold

20 dwts. (pennyweights) brown gold.
10 dwts. mercury.
1½ dwts. chloride of silver.
1 dwt. bismuth.

Printing gold

½ oz. brown gold.
½ oz. mercury.
30 gr. No. 8 flux.

Bronze gold

2½ dwts. brown gold.
1 dwt. mercury.
2 dwts. copper oxide.
¼ dwt. gold flux.

Chasing gold

20 dwts. brown gold.
14 dwts. mercury.
1½ dwts. silver chloride.
½ dwt. bismuth.
1 dwt. No. 8 flux.

These gold powders can either be mixed with a printer's oil and printed from a copper plate via tissue paper, or they can be mixed with suitable oils for painting on with a brush or application with a machine.

However applied, these golds need burnishing after firing.

Acid Gold Process

By etching a pattern in the glaze with hydrofluoric acid, and then gilding over it, a highly decorative finish can be obtained, the raised parts being usually more highly polished in the burnishing operation. The process involves printing a pattern on the ware with a varnish which protects the glaze from the action of the acid, except in those parts where etching is required (called a resist). Usually a mixture of lampblack and copal varnish is used. After the etching the articles are well washed and then dried and gilded. The resist burns off in the firing, and burnishing completes the operation.

Raised Gold Paste

In this process designs are modelled in relief on the glost with a paste consisting of an opaque white enamel. Usually this is mixed with a yellow pigment before firing on the ware. Many beautiful patterns are modelled by hand in this way by craftsmen, and, needless to say, this type of ware is expensive. The white enamel is a red lead, borax, flint type opacified with arsenious oxide. C. F. Binns gives the following recipe:

1¼ lb. arsenious oxide.
2 lb. red lead.
3¼ lb. flint glass.
1 lb. borax.
1 lb. nitre.

This is calcined and ground and mixed with a yellow colour before use. After firing on the ware it is gilded and burnished.

Liquid Gold

The liquid gold, as distinct from best gold or burnished gold, does not need burnishing after firing. The standard quality contains 11·5 per cent. of gold, and the result is less durable than when burnished gold is used. The addition of about 1 per cent. of rhodium (based on the weight of gold) prevents the gold crystallising and accounts for the brightness. In addition, bismuth nitrate is present as a flux, and other metals appear as

resinates in the formulæ published. Most of the formulæ describe an ingredient called sulphur balsam, which is used as a medium for dissolving the gold (in the form of auroterpene sulphide). The balsam is made according to Hainbach (*op. cit.*) by heating together 16 parts of Venetian turpentine and 80 of rectified oil of turpentine until the liquid is homogeneous. 16 parts of powdered sulphur are then added, and the whole heated and stirred till of uniform composition. During this process 50 parts of lavender oil are stirred in. A solution of one part of gold chloride is added to 8-9 parts of the balsam and well mixed. This gives a resinous mass which can be diluted with lavender oil. Basic bismuth nitrate is added to the extent of about half the weight of gold, and acts as a flux. It has been reported that some turpentines give an unstable solution which deposits gold, and other recipes for the balsam specify linseed oil, or oil of lavender instead.

Fired to about 750° C., this liquid gold gives a bright deposit provided the glaze is not rough. If this happens, the deposit has a matt surface. Sometimes the glaze is deliberately roughened before gilding, so that bright and matt gold deposits are produced simultaneously. Chased patterns can be formed on liquid gold bands by applying a special litho before gilding. This contains the materials to roughen the glaze in the places required to produce the matt pattern in the bright gold on firing.

Liquid Silver and Platinum

These can be applied in similar ways. Liquid silver finds some application in electro-ceramics for making contacts, which are sometimes reinforced by electro-plating. The solutions involve dissolving silver resinate in mixtures of organic liquids, or mixing the powdered silver with a flux and an oily medium.

Details of some German silvering compositions have been given in *B.I.O.S. Final Report No.* 1459: *German Radio Ceramics* (H.M.S.O., London). The bright silver contained small amounts of rhodium. The silver resinate is made by dissolving silver carbonate in melted resin at 126-135° C. (5 parts resin to 8 parts of silver carbonate). The resinate is then powdered. This is dissolved in an organic liquid containing nitrocellulose, methylated spirit, benzylalcohol, nitrobenzene, xylol, methylcyclohexanol monoethyl glycol ether, butyl acetate, and citronella oil. To this is added a solution of sulphur resin made by dissolving 7½ parts of sulphur in 35 of Venetian turpentine. The sulphur is dissolved by heating slowly and an exothermic reaction starts at 130° C. and the process is completed by heating for two hours at 170-175° C. The sulphur resin is solid, and is made up to a 60 per cent. solution by dissolving in turpentine. Manganese naphthenate dissolved in a mixture of xylol, nitrobenzene and turpentine is then added (the solution contains 8 per cent. Mn_3O_4) together with a 60 per cent. solution of resin in turpentine, and a solution of bismuth resinate. The manganese and bismuth ingredients act as fluxes. The viscosity and silver content are adjusted by the addition of mixtures of solvents similar to that outlined above. For mica articles this mixture is fired to 560-580° C., for glass 550-600°C., and for porcelain 700-730° C.

For full details of the solvent mixtures, the reference quoted above should be consulted. Since silver deposits are liable to tarnish in air, they are not much used for decoration, and the so-called silver bands, etc., are platinum deposits. Usually some gold is added for cheapness. Like the other liquid metal preparations, the bright platinum contains the metal in solution by adding platinic chloride to sulphur resin. Rhodium chloride dissolved in sulphur resin is added to give the bright deposit on firing, and the other ingredients are bismuth resinate and a chromium resin preparation. The whole is dispersed in an oil containing benzene, turpentine, nitrobenzene, lavender oil, rosemary oil and alcohol. For use four parts by weight of the bright platinum solution (7 per cent. Pt) are mixed with one part of liquid bright gold (77·7 per cent. Au) and fired to 800° C.

Full details for the preparation of the bright platinum are given on page 222 of the B.I.O.S. report previously mentioned.

Quality Control—I

by J. H. SIMCOCK

(Technical Controller—Ridgway Adderley, Booths & Colcloughs Ltd.)

ALTHOUGH this paper deals exclusively with statistical methods of process control it is not intended to give details of statistical techniques. These are readily available in the literature. The purpose of the present paper is to show the importance of variability in the Pottery Industry, to show that this variability can be measured, and to show that it is usually possible to exert some control over it.

The existence of variability in manufacturing processes is too well known and too expensive to need emphasis. For example, no experienced pottery manager would expect to find two pieces of exactly the same diameter in a bung of flatware on a glost warehouse floor. The basic reason for this variation in size is that the pieces are made one at a time, and that each of them is separately influenced by a number of independent variables. If one attempts to make a list of these variables its length will probably be surprising, and it will almost certainly include the following ten items:

1. The mixing of the body from which the piece was made.
2. The length of time for which the clay was on the maker's bench before the piece was made.
3. The part of the wad from which it was made.
4. The state of repair of the tool.
5. The pressure and lubrication applied during making.
6. The degree of dryness and the age of the mould at the time of making.
7. The position of the piece in the dryer.
8. The quantity of clay removed in fettling the edge.
9. The quality of the biscuit placing.
10. The exact conditions of the biscuit fire.

Fig. 1, shows in diagrammatic form the results of measuring a single diameter across 200 glost china tea saucers drawn at random from a glost warehouse. (A diagram of this kind is called a "Frequency Distribution Diagram." It is constructed by marking on a piece of graph paper a horizontal scale containing all likely values of the variable, and then regarding the sheet as being divided into a series of adjacent vertical columns. As each measurement is completed a cross is marked in the appropriate column. About 100 measurements are usually necessary to produce a useful diagram).

Broadly speaking, the curve enclosing the figure is bell-shaped, and if one considers the circumstances this is the kind of outline which might have been expected. If a manufacturer has set up a process to make saucers of some specific size, it is reasonable to suppose that most of the saucers will be near to that size and that those

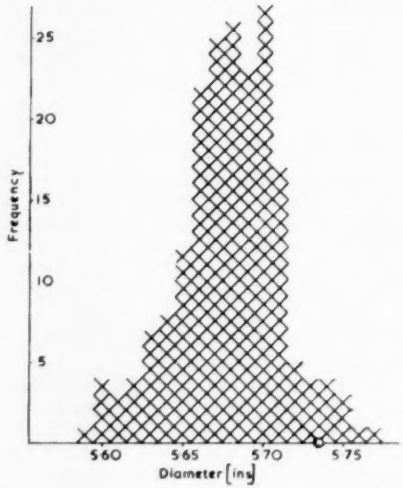


Fig. 1. Freqency distribution diagram from 200 china glost saucers

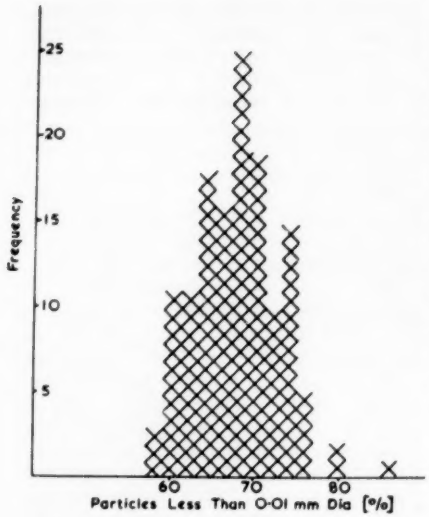


Fig. 2. Frequency distribution diagram from fineness of 150 consecutive deliveries of ground bone ash, from one supplier

which are not are more likely to have a small error than a large one.

A good many processes might be expected to yield results distributed about the average in this fashion. Fig. 2, for instance, shows a distribution built up from measurements of the fineness of 150 consecutive deliveries of ground bone ash to a bone china factory over a period of one year. Fig. 3, shows the variation in moisture content of clay produced by a single press and a single pug. The measurements were taken at two or three day intervals over a period of about eighteen months. Fig. 4, shows a diagram constructed from the "percentage best" figures for a specific making machine on 130 consecutive working days.

It must be borne in mind that pottery manufacture consists of a sequence of independent processes, each of which adds its quota of variability to the product. The effect of this is illustrated by Figs. 5, 6 and 7, which show the weights of random batches of 200 4 in. tiles from the same press. For Fig. 5, the tiles were taken directly from the press and were weighed at once; for Fig. 6, a random batch of tiles from the same press was taken from the biscuit warehouse, and

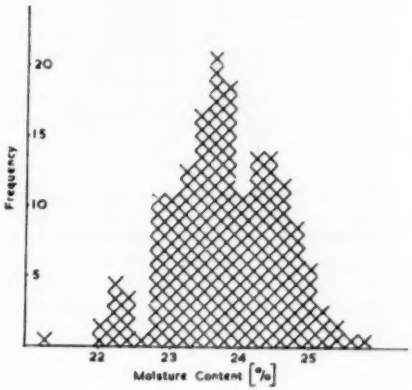


Fig. 3. Frequency distribution diagram from 178 measurements of moisture-content of Bone-China pugged body clay

TABLE 1.

Increase in "range" in weights with increase in number of process variables: 4-*in. Tiles.*

Variables.	*Range about Average Weight as per cent. of Average Weight.*
Dust Packing Density Die Filling Moisture Content of Dust	Clay ± 5 %
Fettling Bisque Loss-on-Ignition	Biscuit ± 8 %
Glaze-take-up Net loss in Glost Fire	Glost ± 10 %

for Fig. 7, a similar random batch was taken from the glost warehouse. It will be noticed that the "spread" in weight about the average is about 20 gm. (or about 10 per cent. of the average) in the case of the clay tiles, 30 gm. (or 16 per cent of the average) in the case of biscuit tiles, and 40 gm. (or about 20 per cent. of the average) in the case of the glost tiles. The way

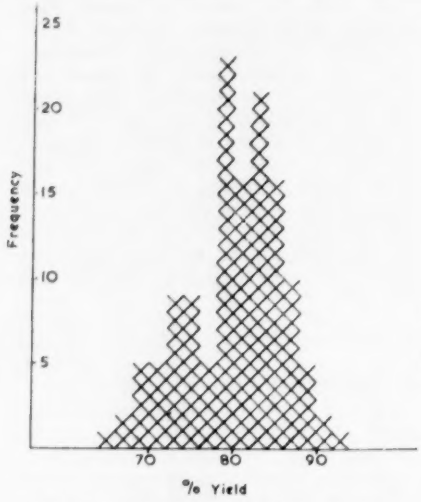


Fig. 4. Frequency distribution diagram from "percentage yield" of a single making machine on 130 consecutive working days

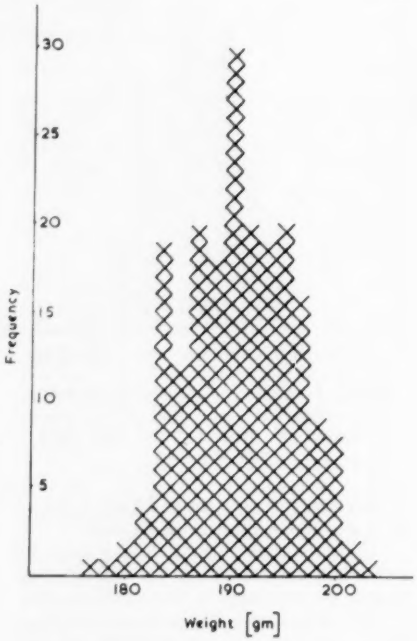


Fig. 6. Frequency distribution diagram from weights of random batch of 200 biscuit tiles from one press

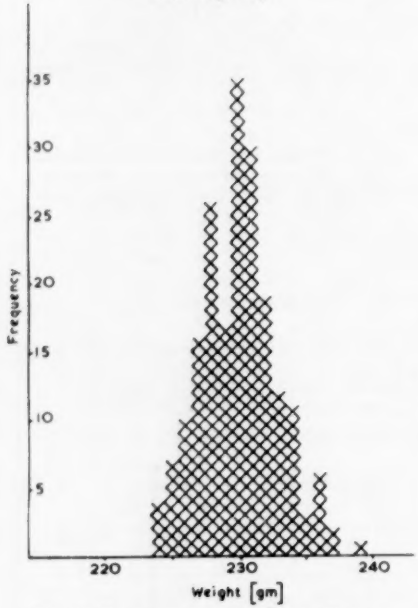


Fig. 5. Frequency distribution diagram from weights of 200 clay tiles made consecutively on one press

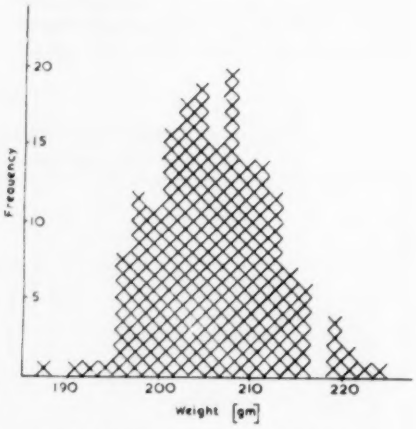


Fig. 7. Frequency distribution diagram from weights of random batch of 200 glost tiles from one press

in which the "spread" in weight builds up with the number of process variables involved is shown in Table I.

Average and "Spread"

In each of the seven diagrams shown above, there are two quantities of fundamental importance. These are:

1. The "central" or average value for the distribution.
2. The "spread" of the values about this average.

(The absolute height of the columns is of no significance, since this is governed only by the number of observations taken.)

The importance of the average value needs no emphasis. (In any case, in the writer's experience process averages in the pottery industry are usually about what they should be.) The object of this paper is to show the importance of the "spread."

Firstly, it would be generally accepted that the lower the variability in a manufacturing process the better. For instance, if the glaze in a dipping house is adjusted to give a correct take-up on ware with 8 per cent. water-absorption, then pieces more porous than this will be over-glazed and pieces less porous will be under-glazed. The over-glazed ware may give trouble from "eggshell," "plucking," running under-glaze colours, "welting," and possibly crazing; the under-glazed pieces may have to be swilled and re-fired, which in addition to the trouble and cost involved rarely recovers more than 70 per cent. of the ware. A double sided tub is only a partial answer to this problem.

Again, it was shown in Fig. 1, that in bone china the diameter of fired flatware varies from piece to piece. The same is true of earthenware, and in either case the difference between the largest and the smallest 10 in. plate in a batch may be $\frac{3}{8}$ in. or more. If a lithograph or border print has been made to fit the rim of a 10 in. plate exactly, it will be necessary to doctor the border to make it fit a plate more than about $\frac{1}{8}$ in. larger or smaller than 10 in. This difficulty will be reflected in slower production and the appearance of "doctored" pieces is rarely as good as it should be.

To take an example from the clay department. A good flat-maker adjusts his technique partly by "feel" and partly by watching the results of the methods he is using in the ware coming from his drier and the biscuit oven. Provided that the quality of the clay he is given is constant he can produce good results from a body which is far from ideal. If the quality of the clay varies from wad to wad or from day to day he is robbed of the basis on which he might relate cause and effect, and his work will not be as satisfactory as it might have been.

A further example might serve to show that variability must be considered when taking technical decisions:

Suppose that a manufacturer has been warned that one of the ball clays he is buying may be expected to run out after about six months. The manufacturer will set to work to find a substitute clay, and he might find from trials two or three clays which have the correct shrinkage, casting properties, fired colour, warpage, and so on. He might then decide to make his choice from these three by finding which of them gives a body with the highest dry strength. He is aware of the misleading conclusions that can be drawn from small-scale laboratory trials in matters of this kind, and knowing that all three clays are generally satisfactory for his purpose he decides to use each of the Ball Clays in turn for a fortnight. Towards the end of each fortnight he takes a large sample of the body from the pug and sends it to a laboratory for Dry Modulus of Rupture determination. Suppose that the results of these determinations were as follows:

Body with Clay A 470 lb./sq. in.
Body with Clay B 500 lb./sq. in.
Body with Clay C 520 lb./sq .in.

On the face of it it would appear that Clay C is the right one to use and that the choice has been made on good factual evidence.

Fig. 8, shows a frequency distribution diagram for the dry strength of a typical Earthenware Body made under good factory conditions. The diagram is built up of 185 observations taken at regular intervals through one year. It will be noticed at once that the "spread" in Dry Modulus of Rupture is approximately 150 lb. on either side of the average, so that an isolated sample taken at random might have

any value between 350 and 650 lb./sq. in. In other words, the values obtained for the body containing the three different clays all lie within the normal variability of an earthenware body, and give no information whatsoever as to which of the three clays gives the strongest body. (This example illustrates an aphorism often used by statisticians—"it is better to be approximately right than precisely wrong").

The Normal Distribution: Measurement of Variability

The object of the above examples is to show that variability is a characteristic of manufacturing processes quite as important as average, and it is now suggested that an average quoted without some indication of the dispersion about it is often of small value and may be very misleading.

The measurement of averages presents very little difficulty, but the measurement of variability is not quite so simple. At first sight it might appear that the easiest way would be to specify the total "spread" from "tail" to "tail" of the distribution. In practice, this is not often convenient, since the tails of a Frequency Distribution Diagram are not usually well-

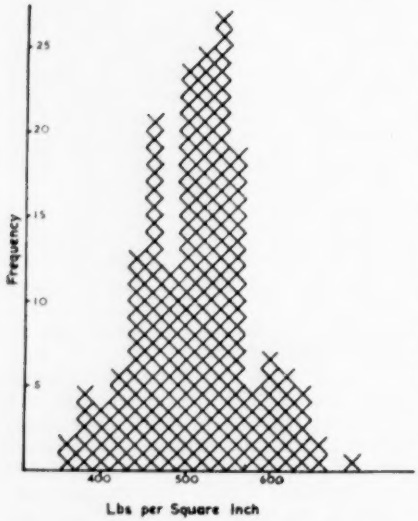


Fig. 8. Frequency distribution diagram from 185 measurements of dry M. of R. of earthenware body taken over one year

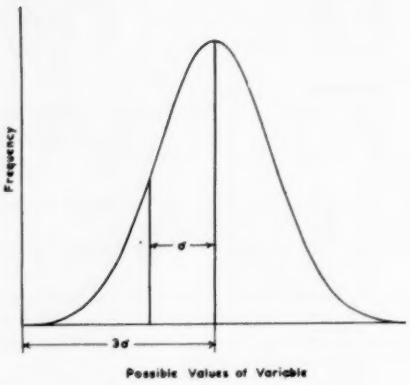


Fig. 9. The normal frequency distribution curve

defined unless a very large number of observations have been taken. For this, and for other reasons, it is customary to make use of the conventional distribution curve shown in Fig. 9. This curve is derived from an equation which relates the average and spread of a distribution in such a way as to give a curve of the same form as that given by the vast majority of Frequency Distribution Diagrams. The equation itself is complicated and will not be discussed here; its usefulness lies in the fact that the curve derived from it can be dealt with by comparatively simple arithmetic.

The "spread" of the Normal Frequency Distribution Curve is measured in terms of a quantity called "Standard Deviation," usually indicated by the Greek letter sigma (σ). As can be seen from Fig. 9, the gradient of a tangent to the curve at either "tail" is for all practical purposes zero. As one moves from the left-hand "tail" towards the centre the gradient steadily increases for a time and then begins to decrease again until at the highest point on the curve the gradient is once more zero. The standard deviation is the horizontal distance between the central axis and the point on the curve where the slope has just stopped increasing and has not yet begun to decrease.

The Normal Frequency Distribution Curve may be considered for all practical purposes to be six standard deviations wide from "tail" to "tail."

TABLE 2.

	Average	*Std. Deviation*
Fig. 1. Diameter of Glost Saucers	5·68 in.	0·033 in.
Fig. 2. Fineness of Bone Ash	69%	6%
Fig. 3. Moisture Content of Clay	24%	1·3%
Fig. 4. % Best from one machine	82%	7%
Fig. 5. Weight of 4 in. Tiles (Clay)	230 gm.	3·3 gm.
Fig. 6. Weight of 4 in. Tiles (Bisque)	190 gm.	5·0 gm.
Fig. 7. Weight of 4 in. Tiles (Glost)	205 gm.	6·6 gm.

Approximations for the average and standard deviation of each of the distributions shown in Figs. 1 to 7, are given in Table 2.

Percentage Total Variability—Technical Control Index

Since standard deviation is expressed in the units of the variable to which it refers, it is not always easy to pick out the more variable items from a list such as that given in Table 2. This difficulty can be overcome by expressing the standard deviation as a percentage of the average to which it relates, giving a quantity known as the "coefficient of variation," but since this coefficient tends to concentrate attention on the centre of the distribution rather than on the tails, the author prefers to multiply it by three to give a quantity called "Percentage Total Variability."

Table 3, shows the Percentage Total Variabilities of the distributions represented in Table 2.

The author has found it convenient to classify ceramic processes into four precision groups, as follows: High precision: less than 5 per cent. total variability; medium precision: less than 510 per cent. total variability; low precision: less than 10-25 per cent. total variability; very low precision: more than 25 per cent. total variability.

Table 4, indicates the magnitude of some of the variabilities commonly experienced in whiteware manufacture. It will be noted that except for pint-weight of casting slip (which is very easily controlled), all the variabilities due to processes within the pottery itself are of either low or very low precision.

On factories where a good variety of process control tests is carried out the monthly average and Percentage Total Variability values can be used as a means of assessing the technical efficiency of the factory.

A list of the kind of tests which might be used for this purpose is given below:

1. Fineness of mill materials.
2. Moisture content and deformation ratio of prepared body clay.
3. Dry modulus of rupture of prepared body clay.
4. Modulus of rupture of mould plaster.

TABLE 3.

	Per cent. Total Variability
Fig. 1. Diameter of Glost Saucers	1·75
Fig. 2. Fineness of Bone Ash	26·0
Fig. 3. Moisture Content of Clay	16·5
Fig. 4. Per cent. Best from one machine	26·0
Fig. 5. Weight of 4 in. Tiles (Clay)	4·8
Fig. 6. Weight of 4 in. Tiles (Bisque)	7·9
Fig. 7. Weight of 4 in. Tiles (Glost)	9·8

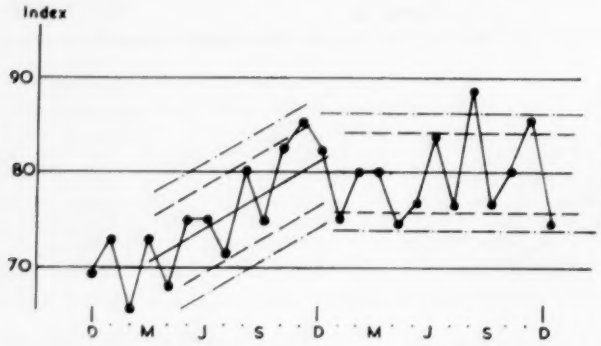


Fig. 10. Control chart showing technical control indices of a whiteware factory for the two years following the introduction of statistical control methods

5. Pint weight and thixotropy of casting slip.
6. Water-absorption of biscuit ware.
7. Edge chipping resistance of flatware.
8. Fineness of grinding of glaze.
9. Craze-resistance of flatware.
10. Adhesion of cup handles.
11. Fired modulus of rupture.
12. Over-all percentage "best" of some item in continuous production.

The tests must, of course, be designed so that they can be carried out rapidly (the average time for each test should not exceed 20 min.), and they should be carried out at least three times per week. There will then be sufficient results each month for an "average" and Percentage Total Variability to be calculated for each item. Permissible tolerances based on experience and other evidence should be laid down, and the number of items in control for either average or variability should be counted and expressed as a percentage of the total.

TABLE 4.

Characteristic	*Units*	*P.T.V.*	*Precision Class*
Fineness of Mill Materials:			
Flint		8-10	Medium
Stone	% < 0·01 m/m	8-10	Medium
Bone Ash	dia. (Hydrometer)	15-20	Low
Glaze		10-15	Medium
Dry Modulus of Rupture:			
Bone China	lb. per sq. in.	20-35	Very Low
Earthenware		15-25	Low
China: Casting Slip:			
Viscosity	°Overswing Torsion Viscometer	25-35	Very Low
Thixotropy		50-80	Very Low
Pint Weight	Oz. per pint	1-4	High
Bisque: Water Absorption:			
Earthenware	%	30-45	Very Low
Cup Handle Adhesion:	lb. tension to		
Bone China: Glost	sever joint	30-60	Very Low
Edge Chipping Resistance:			
Earthenware: Bisque	oz./in.	30-50	Very Low
Glost		50-80	Very Low

The figure so arrived at can be used as a measure of the technical efficiency of the factory. If all items "out of control" are marked in red, the reasons for any fall-off in technical efficiency can be seen at a glance.

Fig. 10 shows the effect of the application of a system of this kind to the technical performance of a whiteware factory. The control scheme was applied in December, and through the following year the index figure improved at the rate of about 1 per cent. per month until the "normal" level of 80 per cent. was achieved. From then on the factory has remained in control at this level.

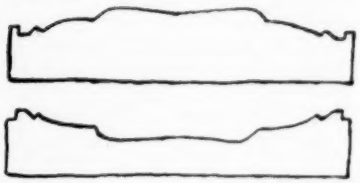
(To be concluded.)

The Use of Synthetic Resin for Cases in Mould Making

by W. L. GERMAN, M.Sc., Ph.D. (Lond.), F.R.I.C.
and J. OLIVER, M.B.E.

SYNTHETIC resins have in recent times been used in a variety of industries for taking casts from originals. The advantages are that the plastic formed from them has an extremely low shrinkage on setting, is easy to pour, does not require a long time for curing, and gives an extremely durable surface, which usually does not require any further work done on it. We have experimented with it for producing cases which we hoped would stand up better to the exceptional wear and tear given them by students than those made in the conventional way from plaster. These expectations have been realised. We have also noted that a similar experience has been obtained by a well-known firm of potters, who have shown us a handle case from which over eighty dozen moulds have been produced, and which is still in service. It should be added that this firm makes a very high-class type of ware and that the selection is of a high order.

To date our work has been done on a phenol-formaldehyde type of resin, supplied as a liquid. This is sold under the trade name of Cataform 318T, by Catalin Industrial Resins Ltd., Waltham Abbey, Essex. It is mixed with an accelerator before being poured. Setting is rapid, and a hard, smooth surface is obtained which faithfully reproduces the fine detail of embossments, etc. No clothing or other work is necessary on the case.



Stages in the preparation of a plastic case. Fig. 1. Plaster shell (number as required)

Method of Use

As an example of the method, the preparation of a 5-in. flat case is given in detail. The model was set up with sufficient spare to be able to turn in a groove to take the metal "back" (Fig. 1). As the resin has a low shrinkage, the ring was given a tight fit on the original pattern. From this pattern sufficient thin shells were taken off in plaster for the number of cases required in the usual way. These were then thoroughly dried out, and three coats of parting lacquer (35/4EV, supplied by the makers of the resin) applied successively. This gives a glossy finish, from which the set resin parts readily. The shells were then "cottled" up with brown paper, pulled up tight with no wrinkles. It is important to attend to the last point to prevent the resin running out (Fig. 2).

Fig. 2. Plaster shell dried and lacquered with brown paper "cottle" round; ready to pour in plastic

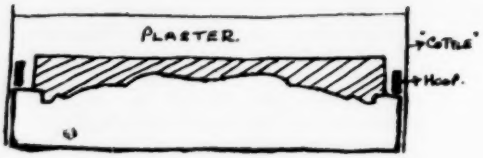


Fig. 3. Plaster set with plastic case placed on

Linoleum or metal cottles cannot be used as the mixture of resin and accelerator appears to attack them, leaving a bad edge on the plastic case. The resin was then mixed with 10 per cent. by weight of the special accelerator provided (316T), and when the mixture was just turning milky for the second time it was poured. (If the resin is poured too early it will, of course, soak through the paper "cottle.") The resin was then set aside to harden in a warm room at approximately 70° F. The setting time will vary with the size of the casting, but in general it will be ready to handle in from six to twelve hours, and normally leaving overnight is sufficient. The case may be used as it is, but, to facilitate handling, the following procedure was adopted. The resin case was placed on a "set," slightly wider than the original (Fig. 3), a metal hoop (hoop iron) made to fit on the edge of this set, and a normal "cottle" placed round and plaster poured in to hold the resin and hoop together. A foot or grip was then turned in the plaster to help the mould maker when shaking was necessary in using the case. The resin is hard enough to take a metal back, and it is not necessary to use a metal ring in the face part of the case (Fig. 4).

Other types of cases than flat have been made since this method was first demonstrated, including those for cups and handle moulds. Handle cases are especially successful, as the handles do not crack off in use. Generally, plastic cases far outlast plaster ones. Bearing this in mind, the cost is not prohibitive. For a 5-in. flat case the cost for materials is about 7s. The possibility exists that this might be reduced by replacing some of the synthetic resin with an inert filling material ground to pass a 200s lawn. Substances like china clay suggest themselves, but before pronouncing on this, experiments will be necessary.

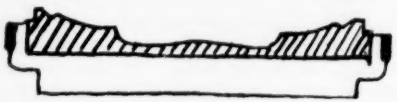
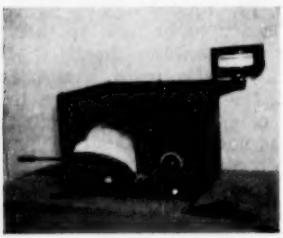


Fig. 4. Completed case. The plaster is depicted by the shaded portion



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Small Intermittent Kilns—a Review

I—"Grafton" Pottery Kilns

WITH the introduction some time ago of a bogie hearth pottery kiln, a complete range of "Grafton" models is now available. The range extends from the small standard sizes for the studio potter and art school to the larger standard models and bogie hearth types for the commercial potter. Standard models are available in two types, one having a maximum firing temperature of 1,100° C. (2,012° F.), known as model EPD, used for biscuit, glaze, on-glaze and under-glaze decoration of earthenware and the other capable of firing up to 1,300° C. (2,372° F.), known as model EP, for the various firings of stoneware and bone china in addition to the applications of the EPD type.

One of the smallest of the former type is shown in Fig. 1, whilst Fig. 2 illustrates the capacity of the largest standard type in the EPD range. The medium-sized standard kiln (model EP3), shown in Fig. 3, which has a capacity equal to the amount of work normally found in studio potteries, has proved popular with the leading pottery teachers of many art schools.

Fig. 1. A small studio or art school kiln for biscuit, glaze, on-glaze and under-glaze decoration

Design and Temperature Control

All standard models are designed to achieve even heating and cooling by the use of the adequate heating elements, in conjunction with correct insulation and refractory materials in proper proportions. The elements are carried in special grooved refractory bricks, which enables them to be removed and replaced very simply. Particular attention has been paid to the design of the doors to eliminate undue heat losses and ensure that temperature uniformity is maintained throughout the chamber. Fixing clamps press the door faces to the kiln mouth and are so designed as to take up the shrinkage of the bricks, thus ensuring that the seal at this point is maintained throughout the life of the kiln.

Temperature control is by means of a rheostat enclosed in the lower part of the equipment casing. The gentle heat from the rheostat provides an ideal temperature for the preheating chamber, also situated below the

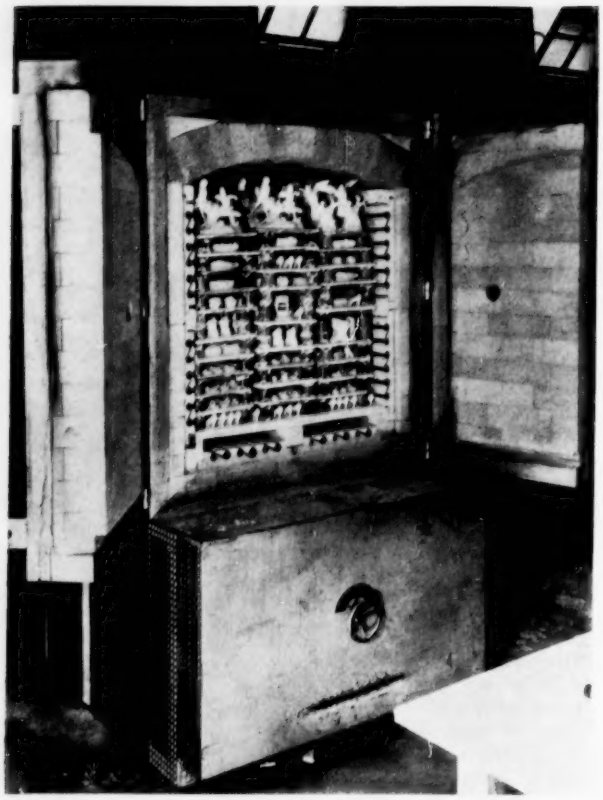


Fig. 2. A large kiln in the "Grafton" range for firing stoneware and bone china

firing chamber. Some form of temperature indication is essential with such control, and the kiln is provided with fittings to take a thermocouple should a pyrometer be fitted.

Bogie Hearth Decorating Kilns

The bogie hearth non-continuous decorating kilns, which are bigger than the largest of the standard range and are built to customers' requirements, are capable of outputs large enough considerably to augment existing production. The internal dimensions of the bogie hearth kiln shown in Fig. 4, which is a typical example, are 48 in. long by 46 in. wide and 42 in. high. It has an output of 105 dozen teaware. The rating is 60 kW and the kiln has a six-hour firing period during the "off-peak" hours. The electricity supply is automatically cut off by a time switch incorporated in the control equipment, and the setting is then drawn on the following morning. To allow two settings and firings in 24 hours, two bogie hearths are employed, so that one can be withdrawn for final cooling outside the kiln and another, already loaded, inserted into the warm chamber. There is no need for the kiln furniture to be disturbed as the hearth, when withdrawn, is accessible on all sides.

It will be noticed from Fig. 4 that the general features of the standard range of "Grafton" pottery kilns are maintained. By having the doors hinged on the main casing as in the standard models, heat stored in the door brickwork is retained to assist in heating the subsequent load, and heat losses are also avoided as the doors can be kept closed until the second bogie is ready for insertion.

Grafton pottery kilns are manufactured by *The Applied Heat Co. Ltd.*, Elecfurn Works, Watford By-Pass, Watford, Herts, from whom further information can be obtained.

Fig. 3. This medium sized standard kiln has proved popular in many art schools

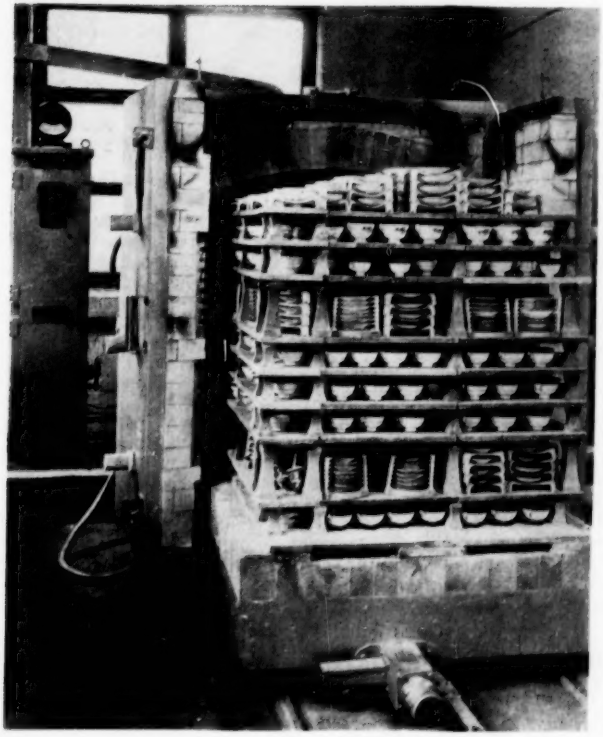


Fig. 4. A bogie hearth non-continuous decorating kiln. This has an output of 105 dozen teaware

Moler Products Ltd.

Clay and Diatomaceous Insulating Materials

SITUATED on the eastern borders of Colchester and on the north bank of the River Colne, the works of Moler Products Ltd. incorporate a number of features of outstanding technical interest.

The insulating materials manufactured by this firm are, of course, well known throughout the trade and are to be found on thousands of sites where heat insulation problems are involved.

Whilst the works is producing to full capacity, the output of finished materials per week is still below the requirements of the order book. Directly, some 10 per cent. of the total goes for export, but the actual export figure is undoubtedly much higher when it is considered that many of the home consumers are engaged on overseas work for customers.

Two Product Ranges

Current products of the firm fall into two separate categories. On the one hand, the M.P. bricks and M.P. aggregate represent the insulating refractory group, which are for applications in the higher temperature range, while high thermal efficiency for low and medium temperatures is provided by "Fosalsil" insulating bricks and concrete. The two groups are, however, complementary to each other in that whereas the M.P. range can withstand high temperatures up to 1,370° C., their insulating properties are not so valuable as those of the "Fosalsil" group, whose upper temperature limit is 870° C. Thus, in general furnace practice, M.P. insulating refractory bricks form either a direct lining or the intermediate brickwork behind the refractory lining and "Fosalsil" insulating bricks form the external brickwork. The physical properties of various materials are summarised in Table 1, and it will be noted that whereas the choice of M.P. grades is largely determined by temperature requirements, the characteristics of "Fosalsil" bricks are in sharper contrast, apart from their identical operating temperature limits.

Raw Materials

The principal raw materials required for the manufacture of these materials are various types of clays and sawdust. For the M.P. bricks, china clay from the St. Austell district of Cornwall, and fireclay from the Midlands, is delivered by rail into private sidings, and for "Fosalsil" bricks, diatomaceous earth from the company's own quarries in Denmark is brought by ship alongside the company's wharf at Colchester.

Keller handling machines conveying diatomite bricks from the extrusion machines to the driers

Moler, or diatomaceous earth, is actually a porous form of silica. Natural deposits of this mineral are the result of the accumulation of the fossil remains of millions upon millions of microscopic unicellular aquatic organisms. One cubic foot of diatomite contains between 50 and 70 million diatoms. When dry, diatomite, although darker in colour, resembles chalk in appearance, but is lighter in weight and more porous.

The chief commercial sources of diatomite are in California, U.S.A., Denmark, Northern Ireland and Algeria, in that order. Rather more limited supplies are found in Great Britain, a recently developed source being in the Island of Skye. The Danish deposits are considered superior to any others in Europe, and the firm's quarries are situated in the Limfjord area.

Mechanised Handling

Mechanical handling of the materials starts at the unloading station. At the commencement of the manufacturing process of "Fosalsil" bricks, the diatomite is loaded on to a belt conveyor for transport to the crushing mill, where it is crushed and ground, after any metallic impurities have been removed by magnetic means. The ground diatomite is then conveyed to the mixing shed, where, depending on the grades in the course of manufacture, combustible materials, mainly sawdust, are added, and, according to the time of year, water also, to produce a suitable plastic consistency. Combustibles play a more important part in the production of M.P. bricks, the china clay or fireclay being basically high conductors of heat and, therefore, requiring a greater degree of artificially produced porosity to provide the desired standard of heat insulation. The clays are ground and specially treated before being mixed with sawdust and loaded into large hoppers prior to the next stage of processing.

From this stage until the bricks are set in kilns, both M.P. and "Fosalsil" bricks pass through identical processes. The accurately-proportioned materials are thoroughly mixed in their passage through the machines, which extrude the clay to any required dimensions. For this purpose the outlet of the machine is adaptable for a variety of different dies, which are easily changed. Thus, the variety of standard shapes that can be extruded are limited only by the cross-sectional area of material emerging from the machine, which must be maintained sufficiently rigid not to collapse before being dried. In cases where larger shapes are required, a decision has to be made whether it is easier or cheaper to extrude the final shape required, or whether the extrusion of a simpler or perhaps more solid shape, which can be mechanically reworked after firing, will prove more economical.

The wet cut bricks are stacked on wooden trays as they come off the cutting table, and these trays automatically fill a loading frame. When a frame is completely filled, a Keller handling machine is already waiting ready to pick up the whole load and transfer it to one of the steam-heated dryers built on either side of a main corridor at the end of the same building.

The extent to which mechanical handling methods are utilised is in fact a feature of the works, making possible the operation of the whole of the plant at maximum capacity with minimum labour force. The Keller handling machines are manually propelled vehicles with a series of rotatable racked finger sets which engage to load, or deliver, sets of bricks laid on suitable wooden pallets. The vehicles themselves run on a cunningly designed and extremely well-laid-out system of rail tracks in which crossing and branching lines intersect at right angles at a turntable.

A single operator can collect, move and deliver a full load without fatigue, and the operation of the system is carefully timed so that the handling machines are returned empty to their respective loading stations at correct intervals, avoiding collision with vehicles moving in an opposite direction.

TABLE 1.
PROPERTIES OF MOLER INSULATING MATERIALS.

Brand	*Recommended temp. limit*	*Density lb./cu. ft.*	*Cold crush. strength (p.s.i.)*	*Thermal cond. B.Th.U./sq.ft./hr./deg. F./in. at mean temp. 930° F.*
M.P.25	2,500° F.	54-55	560	2·7
M.P.23	2,300° F.	54-55	660	2·95
M.P.21	2,100° F.	54-55	670	3·0
"Fosalsil" (solid grade)	1,600° F.	43	790	1·2
"Fosalsil" (Economite)	1,600° F.	32	240	1·1
M.P.25 Concrete ...	2,500° F.	69*	1,940	2·35
"Fosalsil" Concrete...	1,830° F.	57*	2,100	2·0

* *After firing.*

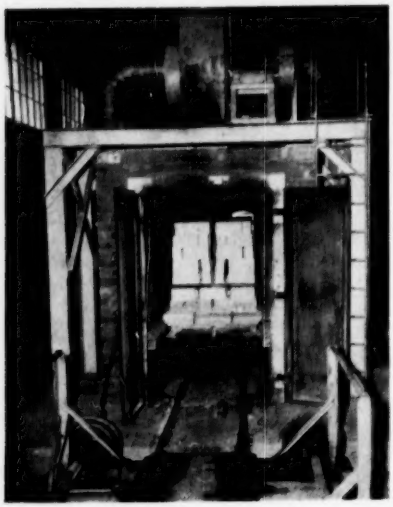
The Kilns

Again the Keller handling machines come into use in unloading the dryers and transferring the bricks to the kilns. The kilns in which all materials are fired comprise two fourteen-chamber Shaw kilns and two Bricesco tunnel kilns. The Shaw kilns which are employed exclusively for "Fosalsil" materials are fired by producer gas, a logical association with the steam plant associated with the generation of steam for drying chambers.

The chambers are loaded by hand, and after building in the wicket, waste gases from the chamber under fire are employed to preheat the forward chambers as the initial stage of the burning cycle. As each chamber cools, the finished bricks are removed for packaging and dispatch.

Very careful attention is given to packing, for whilst the fired brick is rigid and reasonably tough, it is necessary that loads for dispatch are protected with a high proportion of straw packing. Experience has shown that the most economic and satisfactory method of dispatch is to load the bricks into large containers, which are themselves loaded on to railway wagons. This is found to reduce the proportion of breakages or damage in transit to virtually a negligible degree.

In some cases the fired bricks require mechanical processing before completion, and these are removed first to the saw department, where they are cut, drilled or ground according to requirements. The high porosity of insulating bricks make them amenable to saw cutting and a high degree of precision is achieved in the finished articles.



This photograph shows a kiln car about to be withdrawn from the tunnel kiln. There are always thirty-three cars in transit through each of these kilns

The story of firing and dispatch is similar in the larger, modern building, except that the process is more automatic and the two long tunnel kilns are considerably more impressive in appearance, stretching, as they do, the whole length of the floor space. The tunnel kilns operate on a reverse method of firing to the Shaw kilns. Instead of the fire travelling on a circuit through each chamber, the bricks fired in tunnel kilns travel through a stationary fire zone. The tunnel kilns are primarily employed for the manufacture of M.P. insulating refractory bricks, which are taken from the dryers and loaded on to cast iron trucks, with a well-built-up deck of refractory and insulating material, so that the trucks form the base of the kilns.

Individual trucks are advanced for a distance of 6 ft. after entering the tunnel by means of a hydraulic ram. At the end of this travel, both visual and audible signals are given to the operator, indicating that the next truck should be brought up into position, and the ram is returned to its original position. During the period between loading successive trucks into the tunnel, the entrance is kept closed by two steel doors. A complete train of loaded trucks is thus shunted through the tunnel by a continuous process, each truck taking between 40 and 70 hours to complete the journey, depending on the type of material being fired. The middle section only of the tunnel is heated (the firing zone), so that there is a characteristic temperature gradient throughout the length of the tunnel.

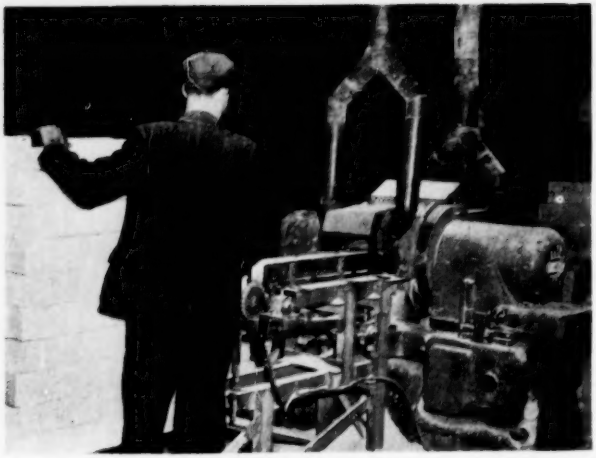
Temperature Control

This takes the form of a fairly sharp rise in temperature from the first section of the tunnel until the bricks reach the temperature at which the combustibles ignite. This represents one of the peak temperatures reached. Over the next part of the travel the temperature at first drops slightly (all combustibles having been burnt out) and then rises sharply again on reaching the firing zone. The ware is then cooled. The temperature drop is fairly rapid at first, levelling off into what is virtually a linear temperature gradient.

Both tunnels operate with a counter-flow of air, i.e., from the exit or "cool" end back towards the entrance end. This both assists cooling in the end section of the tunnel and promotes fuel economy

Here the extrusion machine is seen producing diatomite insulating slabs, the cross-sectional area being controlled by dies fitted to the mouth of the machine

A view of the high temperature burning zone of one of the tunnel kilns during construction showing arch in section. The three courses of insulating bricks which are laid over the 12-in. refractory arch ensure that heat losses by radiation are kept down to a minimum



A batch of M.P.25 insulating refractory bricks recently withdrawn from the tunnel kiln are seen here being fed into a grinding machine

in preheating oncoming charges advancing to the high firing zone. This use of highly preheated secondary air becomes of greater significance the higher the kiln temperatures involved.

Purely from the economic point of view, continuous operation of the tunnel kilns is necessary. Once the tunnel has been heated up to the required temperature the quantity of fuel required to maintain it at this temperature is reasonably small by comparison with plant operating on an intermittent cycle. Having supplied the fuel required to fire the charge, only heat losses due to radiation and convection have to be made good, and this is an essential factor of tunnel kiln design.

Temperatures in the kilns are continuously recorded by instruments. Alarm devices give instant warning of failures or blockages which might prove serious if left unattended.

Whilst this particular building in which the two tunnel kilns are laid out is primarily concerned with firing (and dispatch of the finished products from the cool ends of the tunnels) all M.P. insulating refractory bricks are subjected to further processing before delivery by being ground on all faces. Latest grinding machines are used designed to grind two opposite faces of the brick in a single pass. The four larger surfaces of standard bricks are ground in this manner, the two ends being cut accurately to size by means of circular saws.

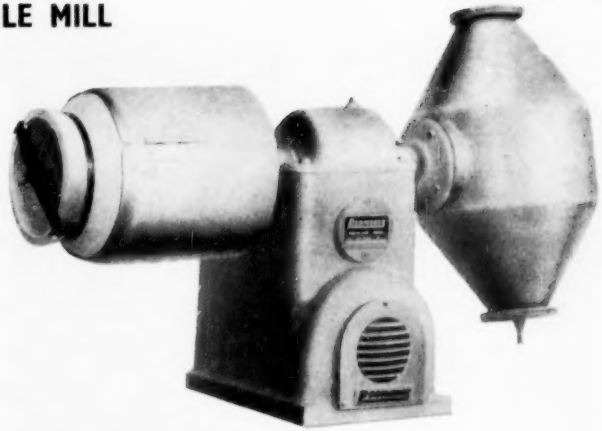
Additional materials produced by Moler Products Ltd. include two grades of insulating concretes and various powders recommended as jointing materials for the different brick grades. An enormous variety of special shapes is produced in addition to the normal arch, chamfer and circle bricks.

Concrete from Brick By-products

The insulating aggregates from which insulating concrete is produced are by-products from the manufacture of insulating bricks. "Fosalsil" No.1 insulating aggregate is a carefully graded material obtained from crushed "Fosalsil" solid grade bricks, and produces an insulating concrete of high mechanical strength, and valuable insulating properties for use up to 1,000° C. The higher temperature demand is met by M.P.25 insulating concrete, which is prepared from a similarly graded concrete produced from M.P.25 insulating refractory bricks.

The bulk of the demand is for low or medium temperature materials in all forms. Nevertheless, increasing calls for high temperature materials used in conjunction with higher processing temperatures, which is becoming common in many industries, are responsible for a steady demand for M.P.25 grade materials, and the laboratory section is continually concerned with further developments in this direction, particularly the all-important question of thermal conductivity. The manufacture of insulating refractories is a highly skilled technique in which continuous research is necessary to improve the over-all physical properties of the products. The leading manufacturers of these materials set their own standards, which are widely acceptable. That Moler Products' standards are high is proved by the high reputation the company has built up during the thirty years since they first started operation.

A VERSATILE MILL



A multi-duty mill with porcelain grinding pot and double conical dry mixer attachments

A MULTI-DUTY mill is being manufactured by Podmores (Engineers) Ltd., of Shelton, Stoke-on-Trent. It is a compact, motor-driven unit which enables a wide range of processes, such as wet or dry grinding and mixing, shaking or polishing, to be carried out with a small capital outlay, since the different attachments can be fitted to the standard unit. The machine is especially suited to laboratory work owing to its size.

The same sizes of pots can be used for both wet and dry grinding, having capacities from ¼ to 3 gallons, but for dry grinding it is recommended that the stainless steel, rather than the porcelain, pot be used. A standard fitting for churning or shaking takes two Winchester quarts; several types of churns or bottle holders can be supplied. For polishing, an octagonal barrel with a total capacity of 0·65 c. ft. can be fitted. Small components up to ½ in. can be polished without any polishing medium, but above that size the use of a powder is recommended. For wet mixing, the same pots can be used as for grinding, either with of without a charge of balls. For dry mixing there is a special double cone mixer which is ideal for laboratory use. The mixer is easily cleaned owing to its good design and lack of complicated mechanism.

Further information may be obtained from the makers.

P. A. Singleton.—Mr. P. A. Singleton, managing director of Monsanto Chemicals Ltd., recently announced the appointment of Mr. N. F. Patterson, director and general manager of production, as operations director responsible for all manufacturing operations of the company.

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Pottery in West Africa

by S. O. OMOREGIE

IN the near future West Africa can depend largely on her own local articles to replace some of the imported ones. One of these is the clay pot and wares. Until recently the trade was small and solely in the hands of women. Nothing can be achieved in the industry without first extracting the clay from the soil, and this is expensive and has discouraged many people.

Pottery-making is one of the oldest industries in the world, having started in Egypt 6,000 years ago. During the last two centuries it became industrialised and spread throughout the world. Pottery in West Africa, in particular in Nigeria, is as old as that in Egypt. Today pottery is more a village concern. In old days no potters could live mainly on the trade alone. But now it is being carried on by both men and women. In some places where farming is the main occupation of the men, they also make pottery with the helping hand of the women.

The extraction of the clay from the soil is the work of the men. The clay is sometimes transported home by the women, and where motor transport is lacking the clay is carried on the head. The clay is then reduced into a soft substance by the women, who do the designs and baking of the pots in the traditional way. The raw clay is sometimes sold in the open market for ready cash.

Every person is thinking seriously on how pottery-making, designing and decorating can be improved. The potters still continue to produce materials very similar to those ancient designs. Now the Nigerian Government is seriously contemplating industrialising the potteries. Recently, an investigation conducted by the Geological Survey Department proved that there are reserves of clay in the coastal area of the Western Region. These might be suitable for ceramic products of all sorts.

The areas examined included Ijebu-de, Okitipupa, Benin, Warri, Badagry, and Ikorudu, near Lagos. These clay deposits were found to be only of local extent. The most popular type is a grey or brown swamp clay. This is often found near water level. They have been held to be of little economic value as they can only be extracted expensively.

It is believed that kaolin is rare, the largest deposit of which being situated near Benin. It consists of grey and brown clay. The reserves available are estimated at 16,000,000 cubic feet.

These earthenware dishes are replacing imported aluminium cups for the collection of rubber latex

Women of West African villages make earthenware storage jars by the traditional method of coiling the clay

A large deposit has also been discovered near Ifaw junction, 20 miles north of Lagos. It is estimated to contain more than 10,000,000 cubic feet of clay. Clay samples are being taken for test in Calabar Province, with the aid of a 30-ton mobile engine. A team of the Shell D'Arcy Oil Company has started the drilling. A depth of 1,000 feet has been reached and samples of clay are being taken by the Shell scientists for test. Another site has been cleared at Ikot Ansa for a similar operation.

Very soon modern machinery for pottery may be introduced in Nigeria. Already people have started to fear that when the new mechanised potters have increased their rate of production the old potters may be driven from the trade. Others, however, hold the view that this may not happen, as the two groups should be able to work together. People will still need clay water-pots, as they are porous and can keep water cool, which the glazed pots cannot do.

It may well happen that the new potters will choose to produce smaller articles, leaving the production of the traditional ware to their old colleagues. It will indeed be a misfortune if the two groups do not work together. Each has many lessons to learn from the other. The new method can be enriched by the principles of the old, while the old method can be revitalised with modern techniques.

Provided that the two methods will co-exist, anxiety for the future of pottery in Nigeria will be needless. There is need to teach the old potter to use the kiln in producing durable wares and to base his designs on local traditions. The new potter will need to produce ware that will be easily recognised as Nigerian, as any design which does not show local tradition is foreign. Nigerian ways of life must be made known in her pottery. This may be a difficult matter until the old artists are consulted for inspiration. Will there be a time when Nigerian pottery can stand competition in the world market? The answer is yes. Now, locally made clay cups for collecting rubber latex have been fashioned to replace the imported aluminium cups. Similarly, many other useful products are beginning to be made. Nigerian potters are beginning to realise the benefits of industrialising their own pottery.

In recent times ceramics in South Africa have been marketed for industrial and domestic purposes and for ornamental lines. In that country native art forms have seen the light of the day. It is felt that if the new potters in Nigeria make similar use of traditional shapes and decoration derived from native sources, the pottery will not only find a good sale in the country but may have something to teach European potters making ware to export to West Africa.

Recent Developments in Glass Production

RECENT researches in glass compositions have made it possible to reflect light, transmit light, and also absorb heat in a manner which previously had not been accomplished. During the late war period, the need for increasing the efficiency of optical instruments and radar equipment made fresh techniques for controlling light reflections a matter of necessity. In pre-war years, anti-reflection systems were generally limited to glass, and were practical for small pieces only, and hence this research has broadened the usefulness of reflection control. As a consequence, without the use of acids or cumbersome equipment it is possible systematically to control light reflected from large areas, whether these are represented by glass, paper, photographic prints, or other surfaces. The ability to increase reflections as well as reduce them still further enhances the value of these reflection control techniques. For different applications, three general types of reflection-reduction coatings have been developed, which range from efficient coatings of great durability to highly efficient coatings of moderate durability. The chemicals which produce the coatings may be applied either by spraying, swabbing, dipping, or spinning, depending on the size and shape of the substance undergoing treatment. In the ordinary way, clear glass transmits some 92 per cent. of light with the remainder lost through reflections but, by this new technique, the 8 per cent. reflectivity can now be increased to more than 70 per cent. A piece of glass so treated, although otherwise transparent and easily seen through, resembles a mirror in that an observer can see his face reflected in it. The amount of reflection can be increased or diminished by the coatings applied. When treated in this way, a reflecting glass can also be made to acquire the characteristic of a filter. This has already been taken advantage of in researches in taking colour pictures, since certain colours are transmitted while others are reflected.

Advantages Gained by Heat Absorption

In other directions, windows made of this glass can reflect the sun's heat rays from houses which are air-conditioned, and also from vehicles. The same conditions apply to one-way glass doors or windows for ovens and refrigerators. In this latter instance, the glass is opaque until an interior light is switched on, when its transparence then becomes apparent.

(Structural and decorative coloured mirrors represent further developments of this coated glass.)

In the matter of absorbing heat, other ramifications of these special glasses prove that it is possible to absorb some 90 per cent. of infra-red or heat radiations, and transmit approximately 85 per cent. This is out of a possible 92 per cent., since 8 per cent. is always lost by reflections, but the light transmission can be increased by 85 to 90 per cent. if the reflections are reduced by glare-removing methods.

This has resulted in a colour-transmitting, heat-absorbing glass, with great possibilities not only for the projection of colour pictures, but for cooler working conditions for actors in motion picture and television studios. This is because the glass is intended for use in floodlights and spotlights as a heat screen. Since approximately 90 per cent. of the heat is absorbed by the glass, the film and television actors are protected against any heating effects which the powerful light could otherwise generate. In the same way, when the glass is alternatively utilised in the projector as a heat screen, films and slides are protected against burning or damage, since the heat emitted from the light source is absorbed. A further advantage of this heat insulating property is seen in the fact that the projector may be stopped to study any specific projected scene, possible only if the film is protected by heat-absorbing glass. It has been contended that colour projection will be further extended in schools, homes and theatres as a result of this safety measure, while various colour reproductions of works of art, printed works, and other valuable objects which otherwise might be endangered, may be projected with impunity.

Nature of the Composition, and Further Uses

As distinct from the purely glareless glass, which although transparent, func-

tions as a mirror, and is obtained largely by subsequent coating methods, the heat-absorbing glass largely depends on the method of initial manufacture. The ingredients include ferrous iron, supplemented by various conditioning commodities to act as the heat-absorbing agents, while otherwise made up of oxides of silicon, aluminium, and phosphorus. The work of melting, moulding, grinding, polishing and fabrication does not differ from that of the normal handling of glass in the ordinary way.

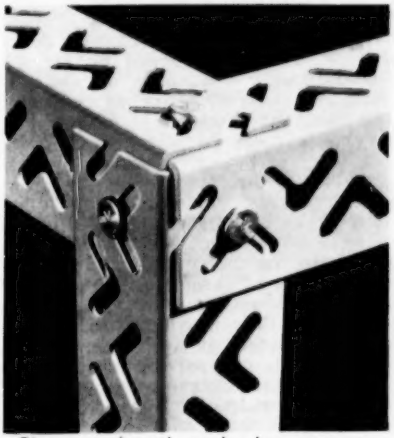
Without necessitating a surfacing treatment, the glass can resist weathering, and not only is chemically stable, but transmits colours with precision. The system of reducing reflections has been still further developed in connection with binocular and camera lenses, besides prisms, etc. A gain of more than 60 per cent. in light transmission is claimed for these improved light techniques, whereby in dim light, observers are enabled to see distant objects better.

A light loss of nearly 43 per cent. is now reduced to not more than 10 per cent. when this glass is used in an optical instrument containing a series of seven lenses, while the lens speed is increased and false images or ghosts minimised in respect of camera lenses.

CHEVRON SLOTTED ANGLE

THE slotted angle bars for the quick erection of structures for a multitude of purposes have been developed recently a stage further by Chevron Structural Units Ltd., who on the basis of a geometrical arrangement have so designed their bars that blind spots can no longer exist. The slotted angle can now be cut anywhere without any fear of there being no facilities for bolting the pieces together. This development also prevents waste since several pieces, however small, can be joined together to form bars of any length or may alternatively be used as fishplates. The illustration shows the design of the new slotted angle bars and gives some idea of the scope of their application.

Further information may be obtained from the manufacturers at 7 Victoria Street, Westminster, London, S.W.1.



Chevron slotted angle bars are so designed that blind spots do not exist. The truth of this statement is well shown here

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Ceramics in South Africa

GLASS BLOWING INDUSTRIES (PTY.) LTD., P.O. Box 2513, Johannesburg, are engaged in the production of all types of laboratory and scientific glassware, and production has been much improved as a result of the internal reorganisation recently completed. This firm was founded by Mr. K. A. Herb, who is continuing as technical director, but certain other changes have been made on the board of directors, which is now headed by Mr. G. Sheffield who is advising on financial matters as well as acting as chairman. The firm states that it is producing a very wide range of scientific glassware and in particular laboratory glass apparatus to the specifications of universities, chemists, industries and other users of such glassware. They are also doing a considerable amount of manufacture to the special designs and other requirements of commercial firms. The repair of scientific glass apparatus is another of their activities. In addition to the laboratory glass division, the firm has a novelty glassware section in which is produced a wide range of commercial glassware articles for commercial sale, such as glass bottle "tot" measures, wine and brandy glasses, glass cocktail freezers and glass miniatures, clear glass wall vases and many other items along these lines. While many of the products made by this company may be easier to import with the relaxation of import control, the firm is confident that it will be able to meet competition of this sort, and in the recent large extension scheme a number of the latest machines were installed for the production of ampoules and test tubes.

Polarizers Expansion

Polarizers (South Africa) Ltd., who are manufacturing the Polaroid sun-glasses as well as distributing a number of imported lines, have found the demand for their products so strong that they have had to move into larger and better-situated premises in Unizen House 12 Viljoen Street, Lorentzville, Johannesburg. The South African general manager is now Mr. E. W. L. Pilkington.

New Glass Centre

The Glass Centre, MBS Buildings, Simmonds Street, Johannesburg, has been opened by the Shatterprufe Safety Glass Co. to act as glass consultants to architects and others, especially in regard to giving advice on the application of glass in building construction.

New Cape Town Tile Factory

Hardcrete Industries (Pty.) Ltd., 831 Grand Parade Centre, Cape Town have a new factory at Kuils River just outside Cape Town's municipal boundary in which the Stelcon tile is being manufactured for industrial and other uses in South Africa, and due to the hard wearing qualities of these new tiles it is expected that they will enjoy a very wide demand in South Africa for flooring and other purposes, as they have a tough wearing surface, able to take heavy loads. The tiles are being made in the size 12 in. × 12 in., and have an under layer and a wear-resisting top layer, for which selected clays are blended with cement to yield a hard surface. The under layer is made of high-class materials with particular attention to high tensile strength. The South African factory is making three types of tiles, the first of which is a steelclad type, in which the top layer is made of steel chips and cement without adulterants. This type of tile is designed for use in situations where there is a regular flow of heavy traffic, and the steel chips are designed to yield resistance to shock and wear and tear. The second item is the MS tile, which has a top layer of cement, broken natural stone and rust-free hardening material, also designed for hard wear. A tile of this sort is suitable for floors in which there is not only heavy traffic but also damp conditions. The third item is the MS non-slip tile which is made of much the same mixture as the second tile but with the anti-wear top layer slightly washed to create a non-slip surface. It is designed for use in canneries, fish factories and other places in which a non-slip surface is essential. The tiles are available in a variety of dark and light hues, white materials being used in the latter type so that a clean as well as a strong floor is provided.

Ceramic Insulators

While the pottery and glassware industry has made great strides in South Africa in the past ten years, the most important industrial product of this industry is certainly insulators of several types for the electrical industry. Much of

the other output of the industry consists of novelty items, which may have to meet increasing competition from imports following a large relaxation of import control. Considerable investigation has been made over the years of the deposits of suitable raw materials in South Africa. Suitable clays have been found in several regions for the manufacture of pottery and allied lines. In regard to kaolin and clays, kaolin occurs as a decomposition product of granite over very large areas, but has not yet been worked, except on a very small scale in the Transvaal and Natal, and on the Cape Flats, where, however, its occurrence is not directly associated with granite. Pottery works have been using clays from the recognised coal measures, and these clays have been available in suitable quantity for making decorative pottery ware, in the production of which several firms are now profitably engaged. The bulk of this clay is obtained from a few places in the Transvaal, but there are deposits in parts of the Cape also being worked. The South African industry is handicapped by the fact that it cannot easily find the raw material for the production of white china ware, the demand for which is strong. Thus many of the articles of this type normally used in South Africa are of British origin, with competition from several continental producers.

Governor Sees Kenya's Kyanite Industry

Sir Evelyn Baring, Governor of Kenya, recently visited the Kenya Kyanite Company mine at Murka, close to the Tanganyika border at Taveta.

Dr. E. Parsons, a director of the company and a consulting geologist, showed Sir Evelyn the kyanite rock which is mined and processed at Murka to produce mullite, a material used extensively in lining steel, glass and other furnaces. After examining the formation of the rock, the Governor saw Africans quarrying a 1,000 ton "lens" of high-grade kyanite worth some £25,000 when processed.

Touring the mine's £400,000 processing plant, the Governor showed great interest in the various stages through which the kyanite rock goes before it is calcined and packed for export to Europe and Japan.

The Murka mine was one of the world's chief producers of this refractory material, but production has been interrupted to allow for the installation of new equipment. This will increase output to about 800 tons per month.

Increase in Capital

The Marley Floor Tile Co. (S.A.) (Pty.) Ltd., of Nigel, Transvaal, has recently increased its capital from £40,000 to £70,000.

Personal

Mr. Max Charney, director of Anglo-African Glass (Pty.) Ltd., Johannesburg, is on an extended visit to Europe and the U.S.A., where he will study the latest glass developments.

Clay Minerals

Investigations into the methods of identifying various minerals, particularly those of interest to the ceramic industry, have been continued in South Africa, and by means of differential thermal analysis, *X*-ray diffraction analysis and chemical analysis numbers of samples of clay materials have been studied to determine their relationship, properties and possible use in industry. This work is being done by the Council for Scientific and Industrial Research in close co-operation with the Geological Survey. Two papers have recently been published by officers of the N.C.R.L and Geological Survey jointly dealing with the application of differential thermal analysis methods to South African minerals and the identification of the clay mineral attapulgite in a Springbok Flats deposit.

Jenolite Ltd.—Jenolite Ltd., the anti-corrosion and metal pretreatment specialists, of 13-17 Rathbone Street, London, W.1, announce the appointment of a new technical sales representative, based on the London area.

He is Mr. L. F. Parsons, of Chiswick, who was formerly with Odhams Press as sales supervisor in the Manchester area. Mr. Parsons, a specialist in engineering subjects after eight years' engineering experience in the Royal Navy, was also for three years maintenance engineer at the American Embassy (Mutual Security Agency).

DANISH NOVELTY FIGURES

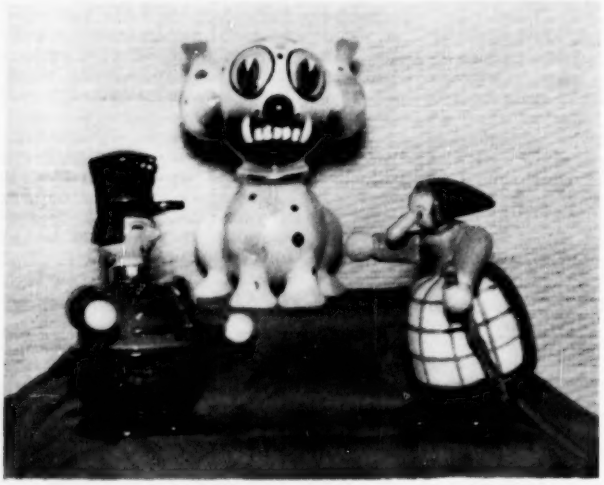
A PREVIEW of some of the pottery figures from Hans Anderson's Fairy Tales, which are now being manufactured by the Danish firm of Soholm Ltd., was held in London recently at the Danish Club.

Only recently has Soholm Ltd. begun to export its pottery, some of which, such as lamp stands, is already becoming familiar in this country. The Managing Director, Mr. Gunnar Christiansen, is responsible for this change in the policy of the firm, which is now 120 years old.

The figures, which are made from English clay, were designed by Mr. Orla Muff, who is a Danish artist and an enthusiastic follower of Hans Anderson. It is believed by Mr. Christiansen that these figures will have a big market both in the United Kingdom and America, since they bring to life many of the characters which are already well known throughout the world. Among those which were on show were the main characters from such stories as "The Emperor and the Nightingale," "The Shepherdess and the Chimney Sweep," "The Tinder Box" (with a very fascinating dog with eyes like saucers), and "Simple Simon."

The Emperor and the Nightingale

The representative of Soholm Ltd. in this country is Mr. V. F. Hampton, of 27 Old Bond Street, London.



Some of the characters in "The Tinder Box." To obtain their fine finish the colours on these figures are fired individually

B.I.M.C.A.M. Annual Luncheon.—The eleventh annual luncheon of the British Industrial Measuring and Control Apparatus Manufacturers Association was held recently in London. At the luncheon Sir Edward Boyle, M.P., parliamentary secretary to the Ministry of Supply, stressed the great importance of the Association's work, more than 90 per cent. of the instrument industry giving it their support. Sir Roger Duncalfe, president of the British Standards Institution, also spoke of its importance and said that living standards could only be doubled in the next 25 years if there is an immense increase in productivity. This could only be achieved by better instrumentation.

THE BRITISH CERAMIC SOCIETY

Preliminary Notice

ARRANGEMENTS have been made for the spring meeting of the Building Materials Section to held on Wednesday, 30th March, 1955, at the Three Tuns Hotel, Durham, starting in the late forenoon, at which a programme of papers is to be read and discussed. In the evening it is hoped that members will attend an informal dinner.

Permission has been obtained from the directors of Crossley Building Products Ltd., for members to visit one of their works on Thursday morning, the 31st March, and from the directors of The Eldon Brickworks Co. Ltd., for members to visit their works at Eldon, Bishop Auckland, in the afternoon.

Because accommodation in Durham is limited, a certain amount has been reserved for the nights of the 29th and 30th March at the Three Tuns Hotel, the Royal County Hotel and the Waterloo Hotel, and intending participants are advised to make early application to the Hon. Section Secretary, stating which hotel is preferred.

NOVEL REFRACTORY CHART

THE ability to substitute large monolithic units for the customary brick by brick construction, and the ease with which intricate special shapes can be quickly made or awkward corners filled up, has made the use of cold-setting refractories almost universal practice for a variety of jobs.

Some users make up their own refractory concrete from mixtures of aluminous cement and crushed well-graded firebricks or grog, while others prefer to use one of the proprietory cold-setting premixes.

Just as no particular make or type of firebrick is suitable for all conditions, so does the type of refractory concrete, or even its suitability, vary, according to the particular conditions prevailing. To help those firms making their own mixtures to be certain that the mix that they are using is the best possible one in each circumstance, the Lafarge Aluminous Cement Co. Ltd. (manufacturers of Ciment Fondu Aluminous Cement) have produced a revolving refractory chart which shows at a glance the various uses for refractory concrete, the most suitable aggregates, suggested mixes and also the hot face temperatures which such mixtures should withstand. Copies may be obtained from the Lafarge Co., free of charge.

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A Wiggin Silver Jubilee.—The Rt. Hon. Viscount Weir of Eastwood, P.C., G.C.B., made one of his rare appearances in public when he took the chair at a luncheon held recently to celebrate the twenty-fifth anniversary of the founding in Glasgow of the Zenith Works of Henry Wiggin and Co. Ltd. Zenith will always be associated with the introduction into Great Britain of "Monel," the ubiquitous nickel-copper alloy developed by the International Nickel Co. of Canada Ltd. It was Lord Weir who obtained the concession to sell this material in Great Britain and its initial development at the Cathcart Works of G. and J. Weir Ltd., soon led to the setting up of a separate company, Monel Weir Ltd. The Zenith Works, as the new factory was called, officially opened in 1929. Soon afterwards, the merger between the International Nickel Co. and the Mond Nickel Co. took place and Zenith Works became an important and thriving department of Henry Wiggin and Co. Ltd., an old-established Birmingham firm engaged in the fabrication of high-nickel alloys and a subsidiary of The Mond Nickel Co.

Drying Earthenware Pipes.—Many earthenware pipe works carry out their drying in simple drying sheds with slotted floors through which the warm air is delivered or by means of stagings built around the kilns. The use of waste heat either from the cooling of ware or from the kilns is now being made, and a system using this residual heat, supplemented by direct-fired air heaters, is now recommended by Sturtevant Engineering Co. Ltd., in their new pamphlet entitled "Drying of Earthenware Pipes." This leaflet and any further information required is obtainable from the above company at Southern House, Cannon Street, London, E.C.4.

INSTRUMENTATION EXHIBITION

AT the end of January, Honeywell-Brown Ltd. invited directors and executives from the ceramic industries to an exhibition of Modern Instrumentation, held in the Midlands Electricity Board Showrooms, Burslem.

The operating advantages of electronic indicating, recording and controlling instruments and associated intrumentation were demonstrated. Representatives from the Birmingham offices of Honeywell-Brown Ltd. explained how the instruments could be advantageously applied to provide precise measurement and control of process operations in the ceramic industries.

To judge from visitors' remarks and subsequent correspondence, the exhibition made a useful contribution to the increasing interest in the many opportunities afforded by modern instrumentation.

Firing Problems and Kiln Design.—Discussing "Firing Problems in Relation to Ceramic Kiln Design," Dr. R. J. Sarjant, Emeritus Professor of the University of Sheffield, said that in modern kiln and furnace design there was more to be learned from a study of heat transmission than from studies of combustion.

With scientific control and proper instrumentation, it was now comparatively easy to maintain high thermal efficiency. The real problems arose in getting the heat where it was wanted.

Dr. Sarjant was addressing a large gathering of fuel and ceramic technologists of the North Staffordshire Fuel Society, the British Ceramic Society, the British Pottery Managers and Officials Association, and the North Staffordshire Branch of the Institute of Clay Technology, at a joint meeting held at the British Ceramic Research Laboratories, Penkhull, in January.

With slide illustrations, Dr. Sarjant summarised work on heat transfer with which he had been associated, and described experimental furnaces, fully instrumented, which enabled heat release and heat transfer to be measured and studied. He showed how excess air affected heat transmission, and demonstrated the conditions necessary to obtain high rates and efficiency of combustion without smoke emissions. He agreed that smoke was difficult to avoid at temperatures below 750° C., but he felt there was much to be said for completing combustion in the combustion chamber or fire mouth, using mechanical methods of firing, and relying on heat transfer by radiation from hot gases and furnace walls, and re-radiation from the ware, rather than on flames of controlled length and pattern. At high temperatures, radiation was by far the most important factor in heat transfer.

Following a discussion, the thanks of the societies attending were expressed by Dr. A. T. Green.

Gibson and Sons Ltd. Shuffle.—Gibson and Sons Ltd., of Burslem, have decided to cease production of general earthenware in order to expand their output of teapots to meet increasing demand from export markets. The firm has two factories in Burslem, each employing just over 200 people—the Albany Works, manufacturing teapots, and the Harvey Works, producing general earthenware. The latter factory will be closed and labour and facilities devoted to the production of teapots. Mr. Philip Bailey, managing director, has resigned from the Board. Mr. Colin Lindop, director and production manager, has become director and general manager, and Mr. K. Wainwright (sales director) director and assistant general manager with effect from 1st January. From the beginning of next year, the firm's sales will be handled by an associate company, Howard Pottery Co. Ltd., Shelton.

D. Turner.—Mr. Derrick Turner, assistant secretary to the British Pottery Manufacturers Federation, has been appointed secretary in succession to Mr. Harry Bowen, who is continuing with the Federation in an advisory capacity. Like Mr. Bowen, Mr. Turner has served the Federation for many years. Mr. Bowen became secretary in 1949, after being a senior official for many years.

Col. G. A. Wade.—Col. George Albert Wade, of Norton-in-Hales, chairman and managing director of the Wade Group of Potteries, Burslem, was knighted in the New Year Honours List. The honour was conferred for political and public services in Staffordshire.

H. Francis Wood.—Mr. H. Francis Wood, managing director of Wood and Sons Ltd., Burslem, a descendant of the famous Enoch Wood, and chairman of the Stoke-on-Trent Savings Committee, was awarded the M.B.E.

Scottish Studio Pottery Removal.—The Castle Wynd Potteries of South Castle Wynd, Edinburgh, will shortly forsake that site, where they have been for the last five years, and start work in a new pottery which has been built at Gifford, East Lothian.

CLASSIFIED ADVERTISEMENTS

FOR SALE

DRUM DRIER for sale, almost new, 6 ft. by 2 ft. 4 in. diameter, complete with reduction gear and connections, in perfect working order. Boiler inspector's certificate available.—Carrigaline Pottery Co. Ltd., Carrigaline, Cork.

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APPOINTMENTS VACANT

GLASS/CERAMIC/VITREOUS ENAMELLING TECHNOLOGISTS, preferably University Graduates, required for Research and Development work on Vitreous Enamels at Laboratories situated in Warrington. Candidates should have had some industrial experience in one of the ceramic fields and be less than thirty-five years of age. Replies should be addressed to: Radiation Ceramics Research Department, Richmonds Gas Stove Co. Ltd., Grappenhall Works, Warrington.

APPOINTMENT VACANT

ASSOCIATED LEAD MANUFACTURERS LTD., Newcastle-upon-Tyne, invite applications for the position of Technical Representative in their Zircon Division. Qualifications required—B.Sc. or equivalent, age not exceeding thirty-five, some experience on the commercial side of industry, a real enthusiasm for selling and developing growing markets for new range of products. The position will involve calling on important customers, mainly in the foundry, ceramic and refractory industries, at home and possibly abroad: also the development of new uses chiefly by discussion with customers and prospective users: there will be regular contact with our Works and Research Laboratories and comprehensive training will be afforded. This is an exceptional opportunity for an ambitious young man to hold a responsible post in a rapidly expanding and entirely new development. A good commencing salary will be paid with excellent prospects of advancement. Replies will be treated in confidence. Apply, giving full particulars of qualifications and experience to Managing Director, Associated Lead Manufacturers Ltd., Crescent House, Newcastle-on-Tyne.

(Classified advertisements continued on page 568.)

APPOINTMENTS VACANT

MULLARD BLACKBURN WORKS LTD. have vacancies for the following:

SENIOR PHYSICAL CHEMIST to take charge of the development laboratory working on ceramic magnetic materials. Some experience of solid state physics and chemistry is essential. The work is closely connected with a rapidly expanding industry, and offers considerable scope for advancement. Salary, depending upon age, qualifications and experience, will be within the scale £800-£1,100. Ref. M/24.

SENIOR METALLURGIST required for Works Laboratory. Candidates should have a good degree in Metallurgy and considerable experience in the investigation of factory problems. The work will be concerned with the metallurgical problems involved in the manufacture of lamps and radio valves, including the production of tungsten and molybdenum. Some experience in powder metallurgy would be an advantage. Age 35-45 years. Salary according to qualifications and experience, within the scale £925-£1,200. Ref. M/26.

METALLURGIST to work on the development of magnetic materials, including permanent magnet alloys. Applicants should possess a degree in Metallurgy. Some specialised knowledge of physical metallurgy would be an advantage. Salary according to age and experience, within the scale £600-£800. Ref. M/25.

Apply in writing, giving full details, to the Works Personnel Officer, Mullard Blackburn Works Ltd., Philips Road, Blackburn, Lancs., quoting appropriate reference.

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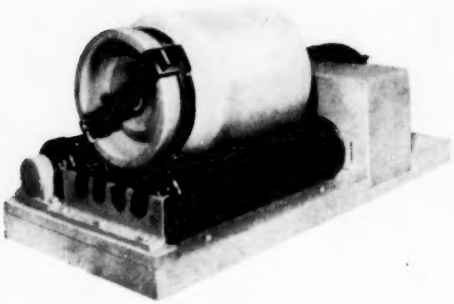

Ball mills are available in several designs to accommodate pots of different nominal capacities, i.e. ½, 1, 1½, 2, 3, 4 and 5 gallon. And various combinations of pots can be set up, such as four ½-gallon or two ½-gallon and one 1-gallon. The 2-roll model illustrated can be set up with either two 2-pint or with one 1-gallon. Standard models are supplied complete with ceramic pots and ball charges, but metal containers and ball charges can also be used and supplied if required.

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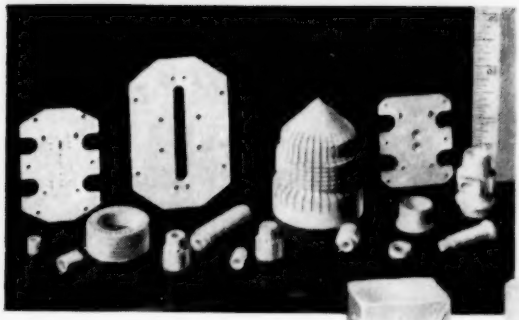

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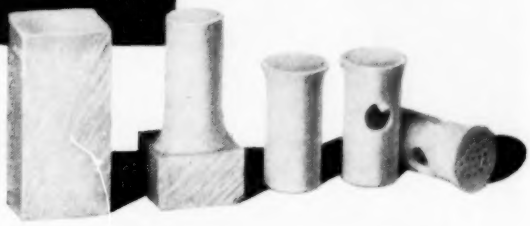

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This is an Arrow Press Publication. Published Monthly.
Subscription Rate 25s. per annum.
Published by Arrow Press Ltd. at 157 Hagden Lane, Watford, Herts.
Telegrams: "Techpress, Watford." Telephone: Gadebrook 2308/9.

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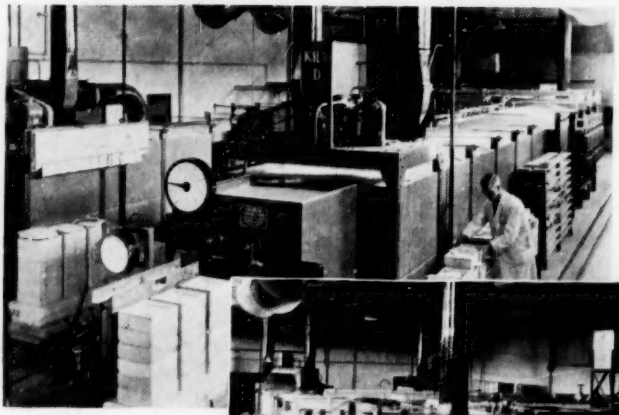

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